VOLUME II

TRANSCRIPT OF RECORD

Supreme Court of the United States

OCTOBER TERM, 1960

No. 501

BINKS MANUFACTURING CO.,
PETITIONER,

vs.

RANSBURG ELECTRO-COATING CORPORATION.

ON WRIT OF CERTIORARI TO THE UNITED STATES COURT OF APPEALS
FOR THE SEVENTH CIRCUIT

PETITION FOR CERTIORARI FILED OCTOBER 24, 1960

CERTIORARI GRANTED DECEMBER 19, 1960

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2318571	May 4, 1943	Manufacture of Abrasives	600	597
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2231324 Feb. 11, 1941 Apparatus for and Method of Making Hat Bats	728	725
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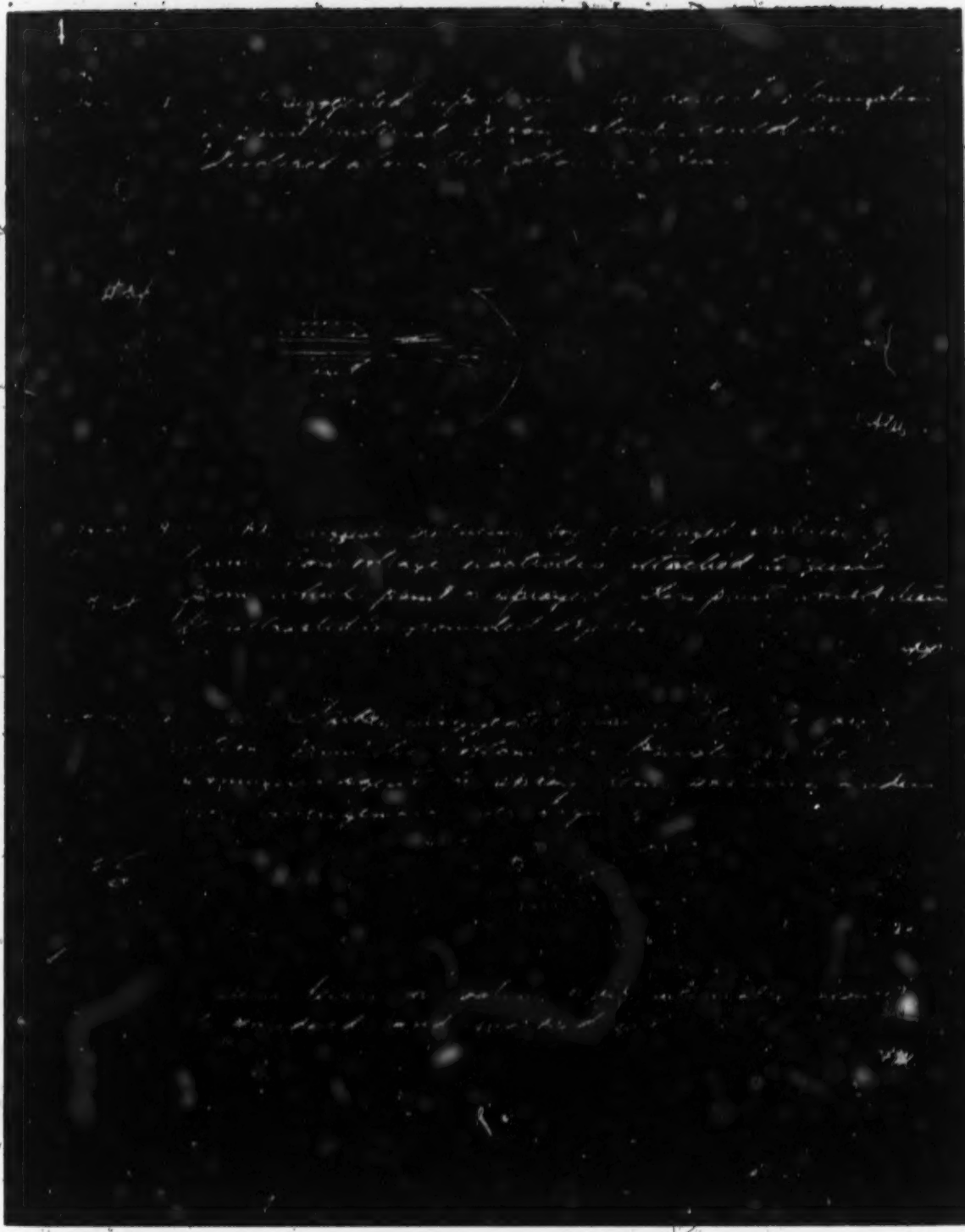

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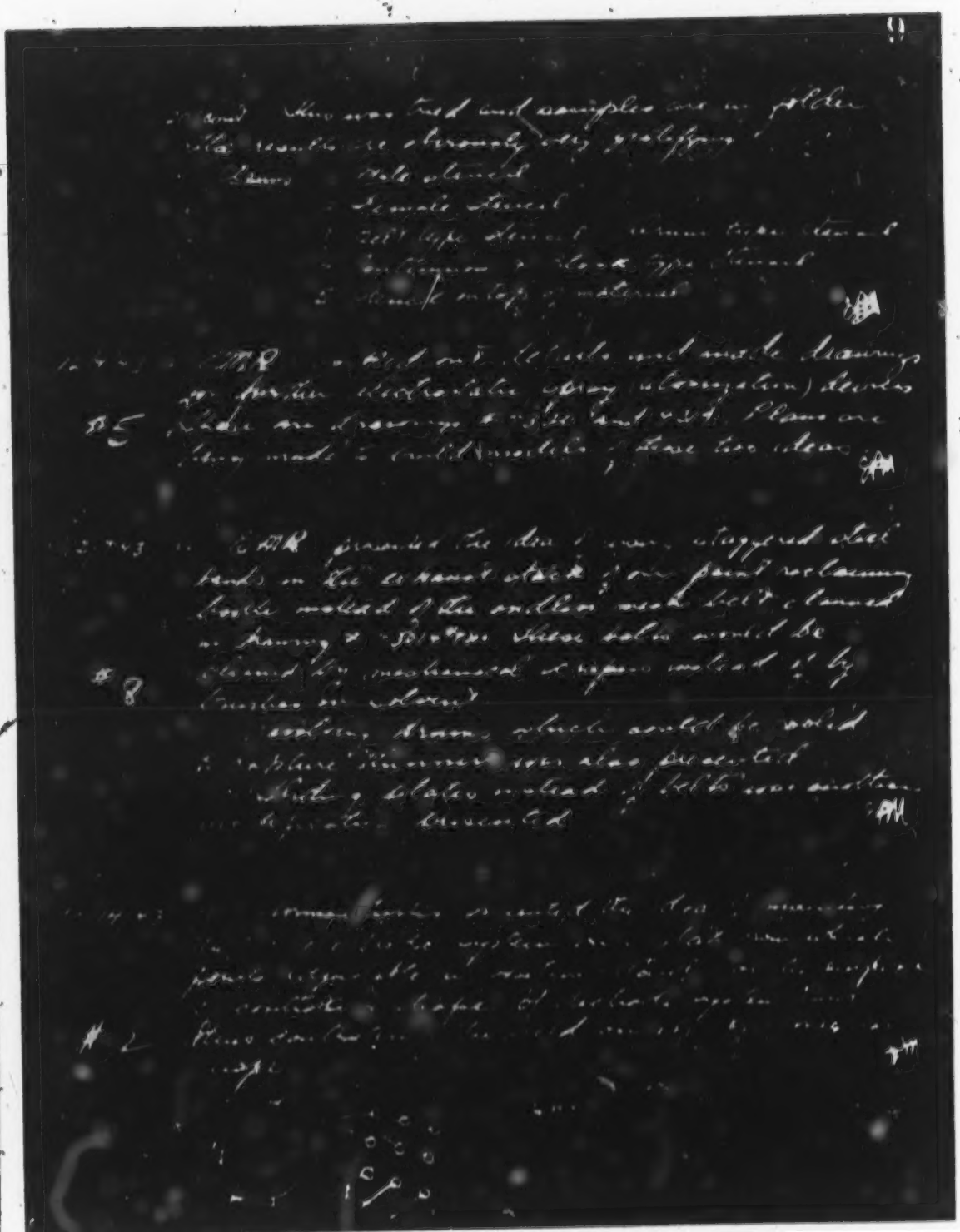

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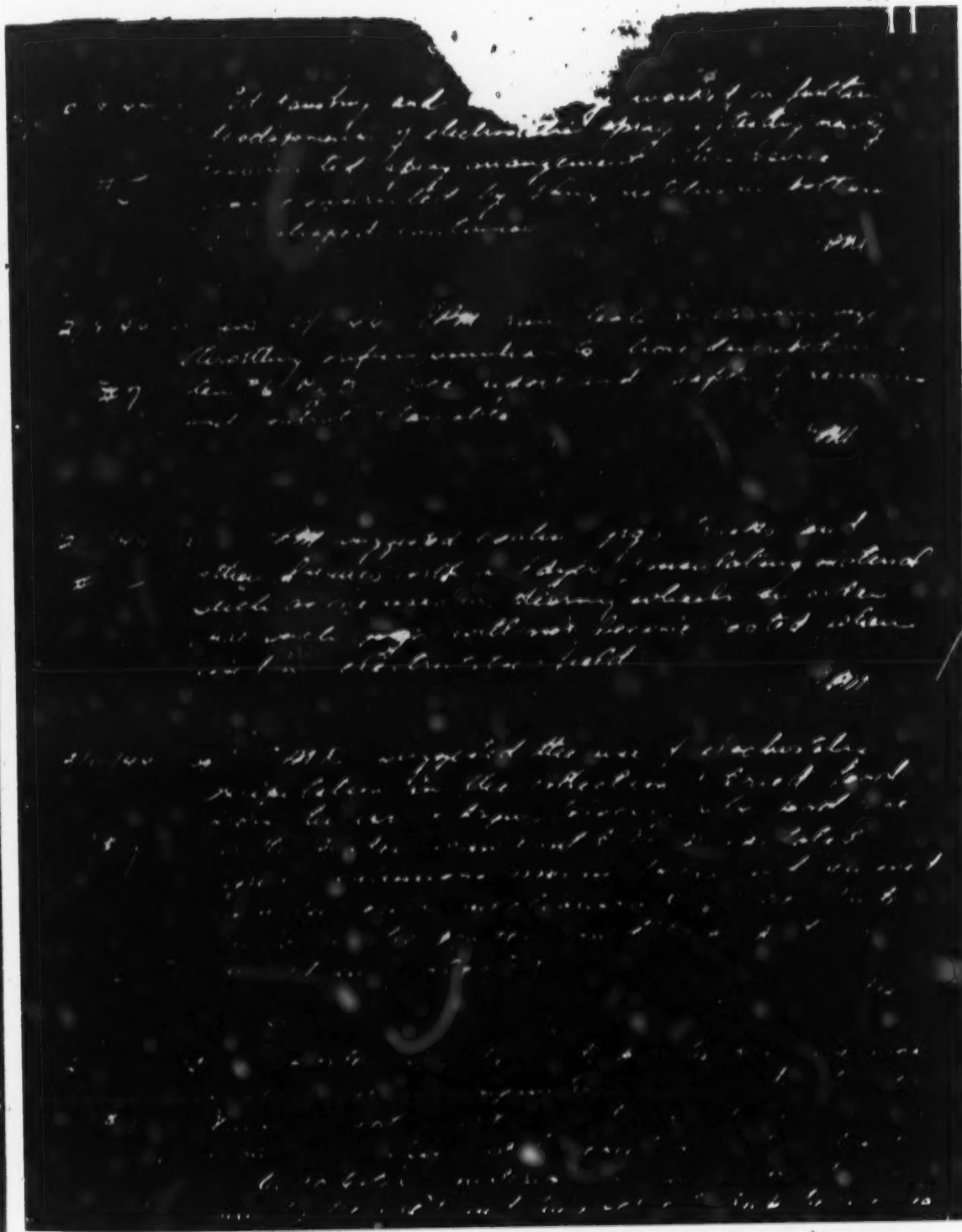

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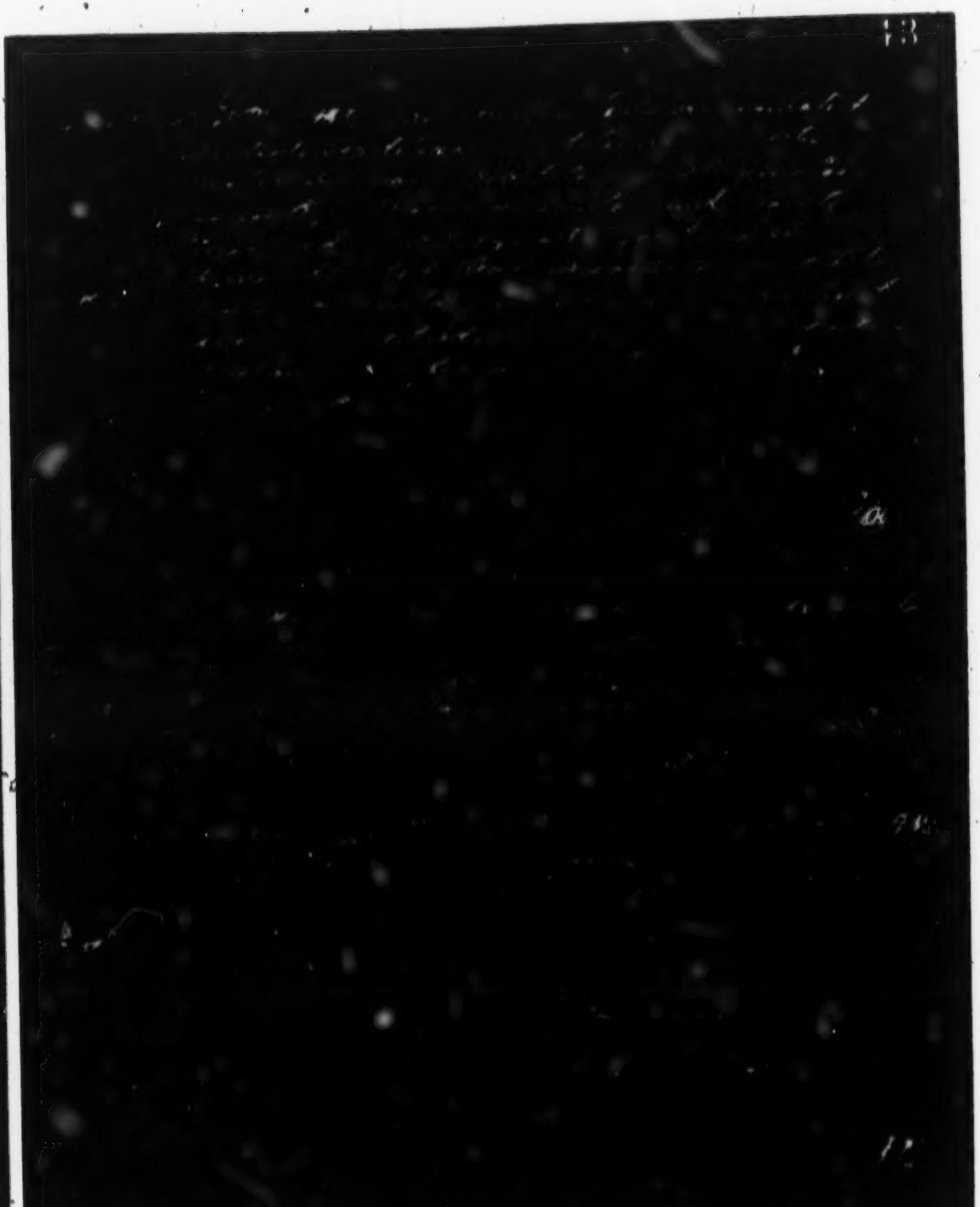

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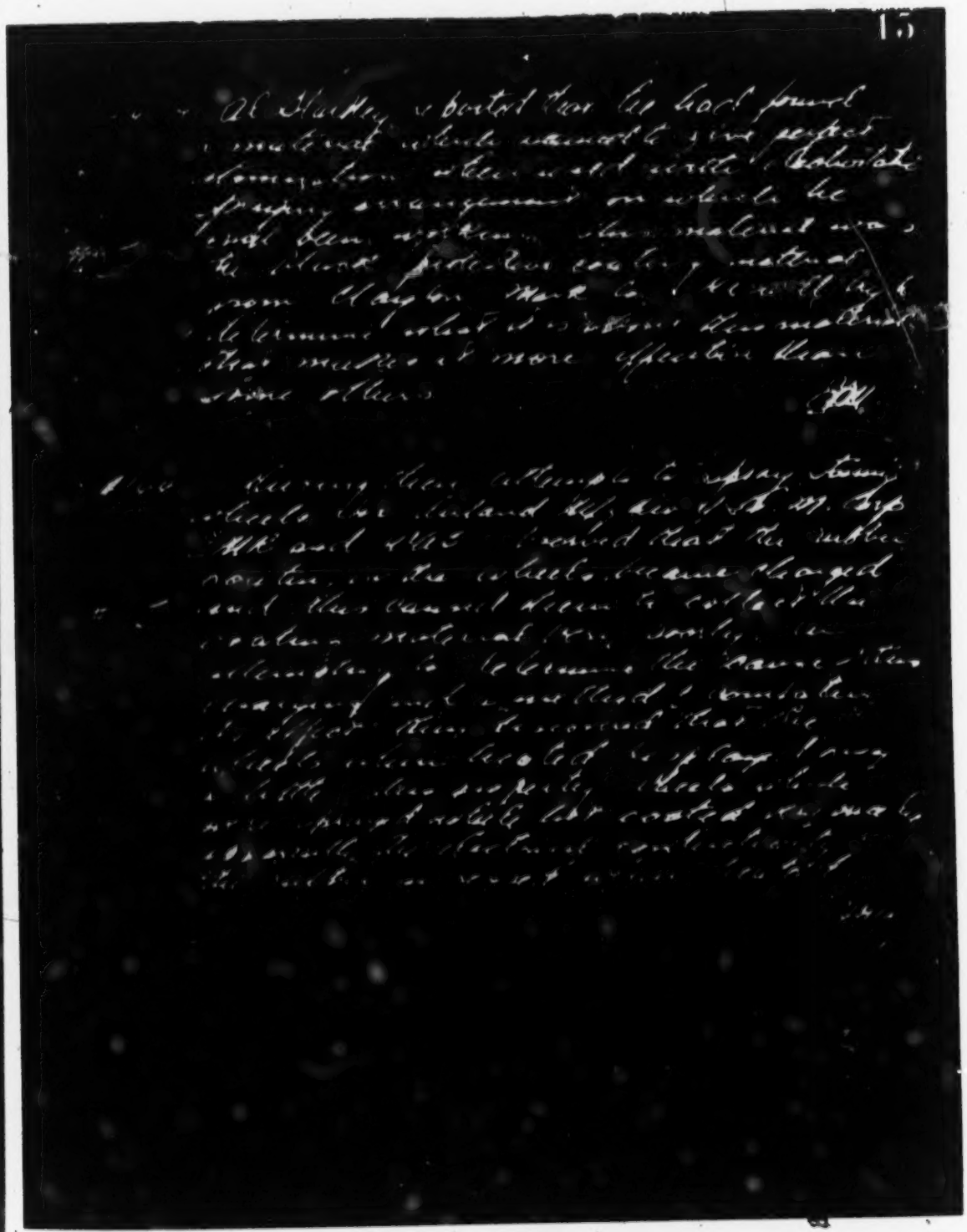


PLAINTIFF'S EXHIBIT R-2.

Harold Ransburg
Ed Ransburg

March 22, 1951

Pricing of the Electro-Coating processes with regard to the Robinson-Patman Act, as well as the Sherman Act.

In the pricing of the electrocoating processes with regard to the Robinson-Patman Act, as well as the Sherman Act, the interpretation is as follows:

In Electro-Coating we are not involved in the Robinson-Patman Act in that it specifically relates to the sale of tangible property only.

The Sherman Act is broader in that it applies to any contract in restraint of trade, which could mean that there might be some possible trouble for us if we differentiated in our pricing policy or structure or amounts between firms manufacturing competitive items.

The firms involved would not necessarily need to be competitive, but if they are the same things they should be treated the same price-wise.

For example, if we were selling to a grocery store in New York and a grocery store in California they obviously would not be competitive. However, making a price differentiation would be interpreted under the Sherman Act, as I understand it, as being in restraint of trade.

Gregg Ransburg.

GR:d

PLAINTIFF'S EXHIBIT S.

July 15, 1953

Acme Visible Records, Inc.
Crozet, Virginia.

Re: Agreement Serial No. 4729.

Gentlemen:

We are writing all of our customers to inquire whether they would prefer a license under which we would supply no equipment and assume no obligation for replacement parts, supervision and service. If, for any reason, you should prefer to provide these items for yourself or to procure them from sources other than our company and return our equipment to us, in your particular case your monthly fees would be reduced by $50.00 per month.

If you are interested in such a proposal, upon advice from you we will send our alternate license agreement.

Yours very truly,

Ransburg Electro-Coating Corp.,
E. M. Ransburg.

EMR/gim

PLAINTIFF'S EXHIBIT Z-1.

May 27, 1953

Ainsworth Manufacturing Company
2200 Franklin Street
Detroit 7, Michigan

Re: Agreement Nos. 2551, 2952 and 3143

Gentlemen:

We wish to inquire whether you would like to convert the subject electrostatic spray licenses to licenses under which we would furnish you no equipment and under which we would assume no obligation for replacement parts, supervision or service, or patent infringement indemnification. If you should elect to assume responsibility for these items for yourself and return our equipment, your basic minimum monthly fee of $100.00 for each unit would be reduced to $80.00 for each unit.

If you are interested in such a proposal, upon advice from you we will send our alternate license agreement.

Yours very truly,

Ransburg Electro-Coating Corp.

EMR/rh E. M. Ransburg

PLAINTIFF'S EXHIBIT BB-1.

May 9, 1955

All-Steel Equipment, Inc.
Aurora, Illinois

Attention: Mr. Paul W. Daley

Gentlemen:

Enclosed please find four copies of our Electro-Spray Agreement, Serial No. 5780, for the electro-spraying of your file cabinets and drawers.

The enclosed agreement provides a license to use our No. 2 Electro-Spray Process and for our furnishing certain additional items, including special equipment, supervision of its installation, and replacement parts for such equipment that becomes defective as the result of normal usage. We understand that you wish this type of agreement rather than one under which we do not furnish these additional items.

If you will kindly sign and return to us all copies of this agreement, we will then be able to sign them, retain two copies for our files, and return the remaining copies for your records. This will then permit us to go ahead with plans for your units. After receipt of these copies, shipment of the equipment will be delayed until the date specified by you. Will you kindly advise us at your earliest opportunity of the tentative date desired, so that we may plan accordingly.

We are looking forward with pleasure to further assisting your finishing operations.

Very truly yours,

JEM:eh John E. Maxwell
Enclosures
CC: Milton F. Pleva

PLAINTIFF'S EXHIBIT FF-1.

September 22, 1953

All Steel Equipment Company
Aurora, Illinois

Attention: Mr. Paul Daley
Finishing Engineer

Gentlemen:

Just a note for your personal records, on September 18, 1953, the Jones-Dabney Paint Company visited our laboratory and we conducted tests for them with the following results:

We ran three paint samples, trying to find grey metallic (non-conductive) which would not have globby appearance when applied to panels. The results were poor—atomization was poor—and globby appearance showed on all panels. The Jones-Dabney Paint Company wants to formulate additional material and return for another visit. Of course, we will be glad to accommodate them in this matter.

We ran a paint test using light grey enamel, trying to match the hand-spray sample of the same material. I will not supply you with other pertinent data regarding these tests unless you specifically request it.

I trust that everything is going to your satisfaction, and if we can be of any further help in any way please do not hesitate to call on us.

Kindest personal regards,
John E. Maxwell
Ransburg Electro-Coating Corp.

JEM:rhd
CC: Milton F. Pleva

PLAINTIFF'S EXHIBIT FF-3.

May 21, 1954

General Electric Company
Buffalo Tube Plant
1495 Fillmore Avenue
Buffalo, New York

Attention: Mr. H. J. Elias, Supervisor
Quality Control Engineering

Gentlemen:

Thank you for your letter dated May 18 requesting information pertaining to our electrostatic painting systems.

We regret to advise that our equipment would not be applicable to the application of coating a glass envelope with a black electrically conductive paint.

We have worked on this particular project with other television picture tube manufacturers, and have not been successful with our experiments.

You may rest assured that if and when we have anything which we believe to be worthwhile for the industry that we will contact you.

We appreciate your interest.

Very truly yours,
Ransburg Electro-Coating Corp.
John E. Maxwell

JEM:rhd
CC: Moine Rowland.

PLAINTIFF'S EXHIBIT FF-5.

March 20, 1952

General Electric Company
Aircraft Gas Turbine Department
P. O. Box 196
Cincinnati 15, Ohio

Attention: Mr. H. E. Mailly

Gentlemen:

This is in reply to your inquiry of March 4 regarding applying high temperature coatings. We do not feel that our present equipment would be entirely satisfactory for such an application at this time. If at a later date, we do feel we have something to offer for such an application, we shall look forward with pleasure to contacting you at that time.

Yours very truly,

Ransburg Electro-Coating Corp.

RHS:mpf

R. H. Stone

PLAINTIFF'S EXHIBIT FF-6.

General Electric Company
Aircraft Gas Turbine Department
Post Office Box 196 Cincinnati 15, Ohio
Telephone Poplar 4100

March 4, 1952

Ransburg Electro-Coating Corp.
Indianapolis 7, Indiana

Gentlemen:

I would appreciate receiving a copy of your brochure on electro-static spraying. I would appreciate any information which you may have on the application of this method to coat irregularly shaped pieces of stainless steel with high temperature coatings.

Very truly yours,
H. E. Mailly
Parts Shop Engineering

yg

PLAINTIFF'S EXHIBIT FF-9.

October 4, 1955

Body Brothers Paint Company
Bedford, Ohio

Attn: Mr. L. F. Body

Dear Mr. Body:

We received the five gallon can of your D-131 aluminum undercoater and have ran some atomization tests here last Saturday to determine how well this material atomized.

I am sorry to report that we had very little if any luck.

We ran what we call static patterns, that is, letting the bell spray against a sheet to determine the particle size and the pattern size and as we feel this is the best way to get a good picture of the atomization. The pattern was quite large—I would say approximately twice the size of an ordinary enamel from a given bell diameter.

The solvent mixes that we used were first, Toluol cut at a ratio of 4:1. This gave a viscosity of 19 seconds on a Zahn #2 cup. The atomization in this case was very poor showing large particles at the outside of the static pattern. The next mix was with methyl ethyl ketone at a ratio of 3:1 which gave a viscosity of 16½ seconds on a Zahn #2 cup. There seemed to be no noticeable improvement with this mixture as we had experienced on previous tests.

We are definitely not encouraged with anything we were able to do toward making this aluminum undercoater work for AMF Cycle. We feel that even if we were able to deposit any half way decent coating on the bicycle itself, that the inefficiency and the messy condition which would go along with it would certainly deter from its continued use. Actually, we have tried many times to work out this undercoater for several of the bicycle manufacturers and to date the results have been just about as outlined above. No luck.

On the other hand, we don't want to look over any possibilities that may come up and if you feel that we should try anything else or run any other tests, please let us have your ideas. Also, if you think that there is anything which you can do to the aluminum undercoaters which would help the situation, we will be glad to continue running tests.

Yours very truly,

R. P. Hughes

RPH:maj
cc—E. J. Sweeney
cc—AFM Cycle Co.
Attn: Mr. Jim Miller

PLAINTIFF'S EXHIBIT FF-10:

July 28, 1954

General Electric Co.
Electronics Division
Components Department
1811 Lemoyne Avenue
Syracuse, New York

Attention: Mr. Stanford R. Amstutz

Gentlemen:

We have your letter dated July 22, and wish to thank you for your interest in our Electrostatic Spraying Processes. The answer to your question as to whether or not our Processes can be used for applying a coating of adhesive to pre-cured paper-base phenolic materials is not a straightforward one. The Processes, as you undoubtedly realize, are primarily intended for the application of coating materials to articles which are of electrically conducting materials. They are also primarily intended for the application of coating materials such as paints or lacquers to articles of this type. These types of materials have a viscosity which is somewhere in the neighborhood of approximately 20 seconds when measured on a Zahn #2 viscosity cup. Both of these factors must be taken into consideration in answering the question which you pose in your letter of July 22. In the first place, I have the feeling that the pre-cured paper-base phenolic materials which you refer to are specifically of insulating character. If this is the case, our processes cannot be used on them since such materials build up surface charges which makes the operation of the equipment erratic and uncertain. Secondly, I have the feeling that the adhesives which you plan to apply to these materials are some-

what heavier than ordinary paints and here also a difficulty would be encountered. Your letter does not give us a specific answer to these two questions and, consequently, I cannot conclude with certainty our possibilities for you. I would surmise, however, that our processes would be ruled out of consideration by virtue of these two points.

I would like to call your attention to the fact that we are using our processes for the application of coating materials to paper laminated panels such as are used on the inner door liners of refrigerators. In this particular case, the panel need not have its electrically insulating properties and therefore, the laminating adhesive can be impregnated with a lamp black material which in the final formed board gives us sufficient conductivity to allow us to use our processes. Something of this character may be possible in your own particular case.

If our processes are applicable, they certainly will produce reproducable results for you as far as film distribution and thickness is concerned. We would have no difficulty in getting for you any film thickness you desire (within reason) and with reproducing this film time after time in production operation.

If you do not believe that our processes would be applicable for the above reasons, then I might suggest that you seriously consider applying the glue to these parts by a roller coat process. Such processes are available, and should be a possibility for you.

If we can serve you further, please do not hesitate to call upon us.

Very truly yours,
Ransburg Electro-Coating Corp.
Emery P. Miller.

EPM:sd

PLAINTIFF'S EXHIBIT II-1.

October 19, 1956

Mr. A. B. Wadsworth, Asst. Purchasing Agent
Allegheny-Ludlum Steel Co.
2020 Oliver Bldg.
Pittsburgh 22, Pennsylvania

Dear Mr. Wadsworth:

Dr. E. P. Miller has advised us of your inquiry concerning our patents relating to our No. 1 Process and our No. 2 Process which you are considering installing in one of your plants. We own the following patents relating to our No. 1 Process:

2,442,986	2,486,877	2,567,781
2,466,906	2,550,657	2,730,460

We own the following patents relating to our No. 2 Process:

2,651,287	2,718,477
2,658,009	2,723,646
2,658,472	2,728,606
2,684,656	2,728,607
2,685,536	2,728,689
2,695,002	2,733,171
2,706,964	2,764,712

In addition, we own the following patents in the field of electrostatic painting which are not limited to any particular one of our electrostatic painting processes:

2,247,963	2,546,701	2,724,661
2,270,341	2,551,035	2,729,191
2,334,648	2,553,724	2,730,461
2,417,798	2,559,225	2,730,988
2,421,787	2,568,611	2,731,589

2,425,652	2,632,716	2,736,671
2,428,991	2,686,471	2,741,218
2,446,953	2,650,329	2,744,033
2,463,422	2,655,128	2,748,018
2,465,128	2,662,833	2,751,564
2,509,276	2,690,730	2,751,851
2,509,277	2,697,411	2,752,883
2,509,448	2,698,814	2,754,226
2,526,763	2,703,549	2,754,227
2,531,542	2,711,155	2,761,544
2,544,806	2,723,921	2,764,125

We also have a number of pending patent applications pertaining to electrostatic painting but for reasons which you can well appreciate it is our policy not to disclose information concerning these pending applications until they have issued as patents. If we can be of any further service to you in regard to your inquiry, please do not hesitate to write us.

Very truly yours,

Ransburg Electro-Coating Corp.
Merrill N. Johnson.

MNJ:dh

PLAINTIFF'S EXHIBIT II-2

October 24, 1955

Subject: General Electric Company
Mattoon, Illinois

On October 18, RHS 'phoned Everett DeVault relative to his check of the sample lamps—per my previous conversation with him on October 14.

Everett stated that they had located samples from the different companies and that they had very carefully scraped the material from these samples and weighed them,

respectively. He said that the results of this check showed 0.9 mg. for our sample lamps, 0.92 mg. for the Paasched samples and 1.2 mg. for each of the DeVilbiss and their own present production samples.

Everett went on to say that the only factor that they could think of which made our tests different from the Paasche tests was that it was necessary for us to use a mask whereas the Paasche gun did not need a mask. He stated that these masks were not available and that it was, therefore, impossible to ascertain how much material we had sprayed onto the mask itself. I agreed with his conclusion, recalling that we did put a fair amount of material on the mask; and it certainly seemed logical that this was the answer we were looking for.

We both concluded that he was probably better off to go ahead with the Paasche spray equipment, I pointed out that it would not cost an exorbitant amount to at least try this equipment out in production. Everett admitted to a strong suspicion that the Paasche equipment may not be rugged enough for production purposes, but stated that he was planning to go ahead with it and try it out to see how they get along. He anticipates excessive maintenance costs with this equipment and said that he would not be surprised if they come back to our proposal in the long run.

Everett went on to say that they are extremely interested in going ahead with coating tests on the other lamps. He confirmed that he has already sent materials to us for test purposes.

R. H. Stone

RHS:maj

PLAINTIFF'S EXHIBIT II-4.

Dec. 16, 1953

Mr. Harold Ransburg

Dear Harold:

I have had two phone calls from General Electric in New Kensington, Pennsylvania. One of these came from Jim Gump and the second one came from George Mild. Both of these fellows are Methods and Planning Engineers and have worked on our set-ups over there.

Originally Jim Gump expressed the need for some sort of triggering system on the individual bells of the triple head. We talked somewhat about it and I explained to him that we had at one time considered this for articles which were spaced on the line but to date had not come up with any definite answers. I then dictated a memo to Don Howarth concerning this thinking, and suggested perhaps he could do something through engineering.

When George Mild called me today—that is on December 14—he was most emphatic that we try and give them something on this triggering. He realized that the means of marketing which we had was detrimental to getting any further work done on the equipment but he stated "I would go to our Vice-President and have him go the the highest man in your organization if I thought it would do any good."

I knew that you had in the past expressed the idea that we definitely needed this triggering on the individual heads and so I told him to contact you by letter as I thought this would probably help him get some of his worries off his chest.

I do not know that their particular problem is any worse than a lot of our other customers. His main complaint was

that all the other operations on the line must all tie together. If there happens to be a slight delay from any one of the other operations this reflects directly at the painting station. Consequently, there is a gap of anywhere from one minute to five minutes of pipe on the line and when they try to shut our equipment down and start it back up again then they have ruined quite a few links of conduit.

Just wanted to fore warn you a little bit about the letter which he will undoubtedly write and I believe it will be very conservative but at the same time very emphatic.

Red

RPH/dj

PLAINTIFF'S EXHIBIT II-5.

Formerly at

Now at P. O. Box 116
Bay Village, Ohio
Phone TRinity 1-0062

August 20, 1951

Air-Way Appliance Corp.
Auburn Ave.
Toledo, Ohio

Attention: Mr. G. M. Burmeister
General Manager

Dear Mr. Burmeister:

Enclosed is a Ransburg Electro-Coating brochure which depicts the theory and operating data on five initial installations of an amazing new process for automatic electrostatic spray painting.

This process designated as "No. 2," in contrast to the well known Ransburg electrostatic spray using conventional spray guns, employs a special type of coating equipment

which is furnished completely by the Ransburg Corp. All that the user needs to supply is the conveyor, workholders and ventilating means.

The efficiency of the new development—in many instances exceeds 99%. There is no overspray to be exhausted. The ventilating means is to carry away the thinner vapors.

Complete laboratory facilities at Indianapolis are available, at no obligation to you, to run simulated production on your parts using your own paints or coating materials. Any item whose production volume justifies consideration of a conveyorized operation may be an application.

Since talking to you in Toledo Friday, I find that I will be in Toledo again on Friday, August 31st, and at that time will contact you to discuss further the No. 2 process.

Very truly yours,

Darrel

Darrel E. Creps

A Distributor for

DEC/s Ransburg Electro-Coating Corp.

CC—to Mr. R. H. Stone

PLAINTIFF'S EXHIBIT II-6.

April 30, 1956

Darrel Creps
Alside, Inc.
Akron, Ohio

Dear Darrel:

You will recall that we discussed the subject company during my recent visit with you in Lima. Upon returning to the office, I have further discussed this matter with Don Howarth. I will try in the following to summarize our opinion concerning it for you.

Darrell, the last visit that we have any record of having made to the subject company was made by Frank Perdue just about a year ago. At that time he said he called at the plant and talked to Mr. Mentall and everything was OK. There is no indication that he saw the equipment nor that he was allowed to see it. In connection with their No. 2 Process, both Don and I feel as though it would be useless for us to demonstrate to them what we could do with this process so long as they are forced to run the parts in the manner which they do now. We are afraid that they would be constantly having headaches with regards to getting uniformity and we feel quite certain that this would be a very pertinent factor in their operation.

In addition to this single fact of lack of possible adequate uniformity, we feel that the additional initial fee to make a change to our No. 2 Process would certainly cause them to have a fit since we are well acquainted with their attitude.

In adition to the initial fee, there is also the question of the monthly fee. At the present time, they are paying us approximately $700.00 and are using somewhere in the neighborhood of $14,000.00 worth of paint per month. This means that if they were to put in our No. 2 equipment, they would obviously owe us approximately twice the monthly fee that they are paying at the present time. I can just hear Jerry Kaufman if this situation were brought to his attention. Another factor which is quite pertinent under these circumstances is that we would, therefore, have to save them approximately twice as much coating material as we are now doing in order to justify our existence with the No. 2 Process. I think that our operation at their plant with our No. 1 Process canot be too inefficient. In order to pick up another $700.00 or $800.00 per month, our No. 2 Process, obviously, would have to be quite efficient when compared with the No. 1 Process which they now

have installed. I am not sure that this would be a possibility for us.

In view of the above, I believe that we should tell Jerry that any of our users on this particular type of item are running the parts parallel to their length through the spray zone and then conveying them through the oven in the other direction.

If he can do this, I think that we could do a job for him and obtain satisfactory parts and uniformity. If he cannot do this, I do not believe that he should be interested in the No. 2 Process.

The above reasons are sufficient to justify his continuing to use the equipment which he has.

We may want to discuss this further when you come to Indianapolis.

Emery P. Miller

EPM:ab

PLAINTIFF'S EXHIBIT II-7.

Altex Corporation
200 West Olive Street
Milwaukee, Wis.

May 7, 1953

Mr. E. M. Ransburg, Vice-President,
Ransburg Electro-Coating Corp.,
Barth and Sanders,
Indianapolis 7, Indiana.

Dear Mr. Ransburg:

I am directing the enclosed check and this letter to you for the purpose of clarifying the record and in the hope that when the facts are obtained by yourself regarding this installation, something can be done to answer our questions and make the necessary corrections to produce a satisfactory job.

We are paying the account in full as you will note, but we do not believe the monthly fees as charged to us are commensurate with the service received and we have expressed this matter in several letters without any answer, other than the curt letter of Mr. D. C. Howarth of April 28th which gave us an ultimatum and dodged our questions in previous letters. All Mr. Howarth had to do was to answer the last two paragraphs of our letter of April 8th and we would have complied with our promises to Mr. Pleva. It was not necessary for Mr. Howarth to outline justification of his stand without recognizing the facts. It is my firm belief that you do not overcome difficulties by refusing to admit they exist.

It is evident that neither Mr. Lueder nor Mr. Pleva reported the conditions at our plant, or Mr. Howarth has chosen to ignore a part of their reports. We are convinced that both Mr. Lueder and Mr. Pleva are cognizant of the following:

1. The first problem of painting of major difficulty was dust. It remained for the paint salesman, Mr. Carl Zipprich, and the Reynolds Aluminum salesman, Mr. Victor Krause, to point out that the electro static charge also charged dust particles and rapidly deposited them upon the product. It was at their suggestion that we put in air conditioning.

2. The difficulty of getting proper thickness of paint without strings on the bells was properly solved by the American Marietta representatives. However, it was found that with the heavy pigment paint that was furnished to your office by American Marietta at the time the experimental panels were run, it required shutting down the line every half hour to clean the bells. This no doubt was not reported and each time we shut down the bells, there was not only loss of production, but the creation of scrap.

3. It was not until we run with the supervision of Mr. Zipprich and their paint expert that we found we were not

able to get uniform thickness across the panel. Mr. Lueder may have known this, but it was never expressed to us. To our knowledge, a check was never made in different localities of the panel until Mr. Zipprich made them and informed us that some other arrangement would have to be set up on positioning of the bells to do a good job of painting. In two of our letters you will find reference to our request for information as to the proper position of these bells to the product. These questions have been ignored by your organization.

4. At the time the test panels were run in your plant, we were informed that the butt end could not be properly painted with your system, but the upper lip that consists of a 3/8 offset at a 60 degree angle could be properly coated with the system outlined by your company. We pointed out to Mr. Lueder and Mr. Pleva that while this could be done on one of the panels, the other panel which was at the outer rim of the spray zone did not get its proper deposit of paint. We have overcome this somewhat in the past few days by using a heavier coat of prime, but this is not good practice because of the nature of the primers employed. It enables us to get a very nice finished job with partial covering of this 60 degree offset and so we have worked out one method to get along for the time being.

We, therefore, have instructed the American Marietta Company to work out a prime that could be used as a heavier roller coat using the electro process for just a light finish. You can see from our point of view that while we are making what looks to be a satisfactory product on the surface, we will not be satisfied until we know that the life of the finish will be equal to the representations made by the manufacturers of the paint. From our observations in the past ten days, we believe that with the proper positioning of the bells and further tests on prime roller coats, we will be able to work ourselves out of our difficulties.

In this connection we wish to refer you to the second paragraph on page two of Mr. Howarth's letter of April 28th regarding the charges for supervisors. We can assure you that we will not require the services of Mr. Lueder or Mr. Pleva in the future and whenever one of your top service managers is in this area, it might pay him and your company to investigate some of the samples of the product taken off the line, not due to dust. It would pay him also to check with representatives of the American Marietta Company who have been invaluable in aiding us in getting to the place we are today.

I regret this long letter and the necessity of bringing it to your attention and we are paying the full amount knowing that you, as a top executive, will see that we are properly reimbursed for a portion of the monthly fees that may be in accordance with the letter of the contract, but certainly not fair in accordance with value received.

Yours very truly,

Altex Corporation,
W. G. Johnson,
President.

W. G. Johnson
MJ

PLAINTIFF'S EXHIBIT KK.

Ransburg Electro-Coating Corp.
Bulletin to Distributors

January 19, 1953

Subject: Trend Toward Leasing Equipment

Gentlemen:

In "Steel" Magazine, January 12 issue, we note the following:

"Gravity and belt conveyors are available on lease under a new rental plan announced by James R. Sebastian, President, Rapids-Standard Co., Inc., Grand Rapids, Mich. This enables firms to install and use the equipment without making a major capital investment. The lease plan is currently available in Chicago, Philadelphia, New York, Buffalo and Grand Rapids."

The following is quoted from "Metal Working Outlet," January 19 issue:

"The trend is to lease, instead of sell, the more expensive capital equipment is gaining momentum. Yale & Towne Mfg. Co. and Automatic Transmission Co. have both just worked out plans to lease their industrial trucks through C.I.T. Corp., the industrial financing subsidiary of C.I.T. Financial Corp. Both manufacturing firms also have corollary plans for users of their equipment who wish to purchase it on installment terms rather than lease."

You may recall discussions in our Sales Meeting of other industrial equipment being put out on a rental basis in Chicago, including large, heavy equipment. Reo Motors is setting up a new company with 18 offices and 1800 trucks to operate on a lease arrangement. Our automatic paging

system we rented from the Telephone Company—no capital investment—no mechanical worries.

On some occasions where strong aversions to royalties are noted, it is well to be aware of this new trend. It would appear obvious that the only reason for the existence of such leasing systems is to save companies the large capital investment for such equipment. Our terms accomplish the same purpose.

It is also important to realize that our initial fee is an expense item. All corporations can pay for it with a 47-cent dollar and if they are in the Excess Profits Tax bracket, they can pay our initial fee with a 23-cent dollar. Their investment is therefore very light and their 30-day cancellation privilege helps us insure all customers against getting stuck with some equipment for which they might not have permanent use.

Harold P. Ransburg

HPR:ch

PLAINTIFF'S EXHIBIT NN.

Ransburg Electro-Coating Corp.
Indianapolis, Indiana

Bulletin No. 100

May 27, 1953

Subject: Pricing Guide

No prices should be considered as a firm quotation until confirmed with the home office. The following may, however, be of assistance in giving more accurate preliminary estimates.

Detearing Process.

With Equipment, Installation Supervision, Replacement Parts & Service:

Initial Fee $3400 per unit
Monthly Fee $50 plus $125 for each 200 (or fraction) hours of usage
Initial Fee $5400 if TWO units operate from one pack
Monthly Fee $50 plus $250 for each 200 (or fraction) hours of usage

Without Equipment, Installation Supervision, Replacement Parts or Service:

Initial Fee $2000 per unit
Monthly Fee $37.50 plus $125 for each 200 (or fraction) hours of usage
Initial Fee $4000 if TWO units operate from one pack
Monthly Fee $37.50 plus $250 for each 200 (or fraction) hours of usage

No. 1 Spray Process.

With Equipment, Installation Supervision, Replacement Parts & Service:

Initial Fee $3000 plus $300 for each spray gun used
Monthly Fee $100 plus: 10% of cost of paint used up to $4000 monthly usage
5% of cost of paint used from $4000 to $8000 monthly usage

Without Equipment, Installation Supervision, Replacement Parts or Service:

Initial Fee $1200 plus $300 for each spray gun used
Monthly Fee $80 plus: 10% of cost of paint used up to $4000 monthly usage
5% of cost of piant used from $4000 to $8000 monthly usage

Number 2 Process.

Approximate Pricing Schedule.

Bulletin #100.

Mar. 6, 1953.

Number of				Initial Fee		Minimum Monthly Fee	
121 Single Heads (1 Pedestal)	Triple Heads	Pump Units	Power Supplies	Non-Cond. Paint	Cond. Paint	Non-Cond. Paint	Cond. Paint
1	0	1	1	4700	5600	150	150
2	0	1	1	5600	6500	150	150
3	0	1	1	6500	7500	150	150
4	0	1	1	7500	8400	150	150
5	0	1	1	8400	9300	150	200
6	0	1	1	9300	10200	200	200
0	1	1	1	5900	6900	150	150
0	2	1	1	7700	8600	150	150
0	3	1	1	—	10300	—	200
0	3	2	1	10600	12400	200	250
0	4	1	1	—	11800	—	250
0	4	2	1	12000	13900	250	300
0	4	3	1	13300	16000	250	300

Number of				Initial Fee		Minimum Monthly Fee	
140 Single Heads (2 Pedestal)	Triple Heads	Pump Units	Power Supplies	Non-Cond. Paint	Cond. Paint	Non-Cond. Paint	Cond. Paint
1	0	1	1	4900	5900	150	150
2	0	1	1	6000	6900	150	150
3	0	1	1	6900	7800	150	150
4	0	1	1	7900	8900	150	200
5	0	1	1	8900	9800	200	200
6	0	1	1	9900	10800	200	200
4	0	2	1	9100	10900	200	200
5	0	2	1	10100	11900	200	250
6	0	2	1	11100	12900	200	250

Pricing Schedule

Integral Motor Discs

Number of		Initial Fee		Minimum Monthly Fee	
Discs	Pump Units	Non-Cond. Paint	Cond. Paint	Non-Cond. Paint	Cond. Paint
1	1	5300	5600	150	150
2	1	6100	6600	150	150
4	1	8100	9200	150	200
4	2	8700	9700	150	200

No. 2 Spray Process.

Initial Fee—Use schedule dated May 6, 1953 (attached)

Monthly Minimum—Use schedule dated May 6, 1953 (attached)

Monthly % of Paint Cost—Determined by home office. To approximate, use attached lists and charts A and B. Make only general conservative statements, as some pertinent factors may not be readily apparent.

Definition of a "Unit."

A unit is comprised of that equipment required to apply (or detear) one coat of paint. This may entail equipment at two effectively adjacent stations so long as both stations apply the same paint (not prime and finish) at a film thickness of not over .00125 inches and without a bake or substantial air dry between stations.

EMR:eh

PLAINTIFF'S EXHIBIT OO.

Ransburg Electro-Coating Corporation.

August 5, 1952

Bulletin to Distributors

Pricing Schedule—No. 2 Process.

Gentlemen:

In order to permit you to have an approximate pricing schedule for our No. 2 Process, we have arranged a table in which various possible combinations of single heads, triple heads, pump units, power supplies, etc., are listed. If you have a reasonable guess as to the number of heads which will be involved on a particular job, then I believe that this pricing schedule will permit you to arrive at a reasonably close approximation of what our initial fee and our minimum monthly fee would be for a particular installation. A copy of this pricing schedule is enclosed for your reference.

So that you will completely understand the various headings the *No. 121 Single Head* is the single head arrangement which is supported on its own pedestal and which is operated from its own integral motor. *The triple head arrangement,* of course, is the standard triple head assembly including drive motor, upright support columns and bases. *The pump unit* is either the standard type pump unit when the coating material is non-conducting or it is the insulated type pump unit when the coating material is conducting. For your information, the standard non-insulated pump unit will accommodate six pumps (two triple heads of six singles), whereas the insulated pump unit will accommodate 12 pumps. *The power supply,* of course, is our standard type voltage supply and control panel. In your considerations, use 4 triple heads or equiv-

alent combinations, as indicated on the pricing schedules, as being a full load for a pack. Also consider that spray stations which are more than 50 feet apart had better have two packs.

Referring to the second page, you will notice there is listed the *No. 140 Single Head.* This is the single head which is supported on a horizontal insulated column similar to the triple head. In this case this single head is supported from two upright columns as is the triple head. We have included this type of single head since in some cases the height of the head above the floor makes the No. 121 Single Head top-heavy and unwieldy. We normally use the No. 140 Single Heads in conjunction with our square patterns where a number of single heads are required above one another to coat a flat extended surface. On page 2 the triple heads, the pump units and the power supplies referred to are identical in all respects to those referred to on page 1.

Also included on page 2 is a tentative pricing schedule for the new disc type atomizer which is driven by its own integral motor.

Shown on this pricing schedule is the initial fee for two types of application, namely non-conducting paint and conducting paint. You will notice the difference in these initial fees and this is primarily due to the fact that the pump unit must be insulated in one case whereas in the other case it can be a conventional type pump. You will also notice that the minimum monthly fee varies depending upon the complexity of the equipment involved.

To aid you in understanding the use of this table, I might cover the following with you. Let us assume that we have an installation which requires 2 triple head units for the coating of both sides of a flat sheet. Let us further assume that each of these triple heads is disposed on opposite sides of the flat sheet and that they are delivering the

identical type of coating material at the same rate. Under these circumstances we would have a set-up which involved two triple heads, one pump unit, one power supply. Referring to line 17, page 1 of the pricing schedule, we see that such a unit would have an initial fee of approximately $7700 if the coating material was non-conducting or $8600 if the coating material was electrically conducting. The minimum monthly fee in both cases would be $150.

Again let us assume that another unit was placed at another position in order to apply prime material on these parts and assume this unit comprised four triple heads, one insulated pump unit, and one power supply. Referring to the table, we see that such a unit has an initial fee of $11,800 and a monthly minimum of $250.

I suggest that you consider the enclosed schedule and see whether or not the various points are clear to you. If they are not, we certainly would appreciate your directing your questions to the attention of the writer and he will try to clarify these various points for you. We plan to send you soon a "Question and Answer Bulletin" covering a lot of details to aid you in fitting this new process to a customer's needs. This should help.

Please notice that the enclosed pricing schedule is only an approximate schedule for your use during initial sales contacts. Final and specific quotations will have to originate from this office and will be calculated more specifically in detail once the exact amount of equipment involved is determined. The variation from the enclosed prices will not, however, be large unless some specific arrangement influences the amount of equipment involved. Please consider this schedule as confidential.

Very truly yours,

Emery P. Miller.

EPM:eh

July 14, 1952

Pricing Schedule—No. 2 Process.

Number of				Initial Fee		Minimum Monthly Fee	
121 Single Heads	Triple Heads	Pump Units	Power Supplies	Non-Cond. Paint	Cond. Paint	Non-Cond. Paint	Cond. Paint
1	0	1	1	4700	5600	150	150
2	0	1	1	5600	6500	150	150
3	0	1	1	6500	7500	150	150
4	0	1	1	7500	8400	150	150
5	0	1	1	8400	9300	150	200
6	0	1	1	9300	10200	200	200
4	0	2	1	8700	10500	150	200
5	0	2	1	9600	11400	200	250
6	0	2	1	10500	12300	200	250
0	1	1	1	5900	6900	150	150
1	1	1	1	7300	8200	150	150
1	1	2	1	8500	10400	150	200
2	1	1	1	8200	9100	150	200
2	1	2	1	9400	11300	200	250
3	1	1	1	9100	10100	200	200
3	1	2	1	10400	12200	200	250
0	2	1	1	7700	8600	150	150
1	2	1	1	—	9900	—	200
1	2	2	1	10200	12000	200	250
2	2	1	1	—	10800	—	200
2	2	2	1	11100	13600	200	250
3	2	1	1	—	11800	—	250
3	2	2	1	12000	13900	250	300
0	3	1	1	—	10300	—	200
0	3	2	1	10800	12400	200	250
1	3	1	1	—	11600	—	250
1	3	2	1	11900	13700	250	250
1	3	3	1	13100	15900	250	300
2	3	1	1	—	12500	—	250
2	3	2	1	12800	14600	250	300
2	3	3	1	14000	16800	300	350
3	3	1	1	—	13400	—	250
3	3	2	1	13700	15600	250	300
3	3	3	1	14900	17700	300	350
0	4	1	1	—	11800	—	250
0	4	2	1	12000	13900	250	300
0	4	3	1	13300	16000	250	300
1	4	2	2	—	17400	—	350
1	4	3	2	16700	19500	350	400
2	4	2	2	—	18300	—	350
2	4	3	2	17700	20400	350	400
2	4	4	2	18900	22600	400	450
3	4	2	2	—	19200	—	400
3	4	3	2	18600	21400	350	450
3	4	4	2	19800	23500	400	450
0	5	2	2	—	18100	—	350
0	5	3	2	17500	20200	350	400
0	6	2	2	—	19600	—	400
0	6	3	2	19000	21700	400	450
0	6	4	2	20200	23900	400	500
0	7	2	2	—	22000	—	450
0	7	3	2	—	24200	—	500
0	7	4	2	22600	26300	450	550
0	8	2	2	—	23500	—	450
0	8	3	2	—	25700	—	500
0	8	4	2	24100	27800	500	550

Number of				Initial Fee		Minimum Monthly Fee	
140 Single Heads	Triple Heads	Pump Units	Power Supplies	Non-Cond. Paint	Cond. Paint	Non-Cond. Paint	Cond. Paint
1	0	1	1	4900	5900	150	150
2	0	1	1	6000	6900	150	150
3	0	1	1	6900	7800	150	150
4	0	1	1	7900	8900	150	200
5	0	1	1	8900	9800	200	200
6	0	1	1	9900	10800	200	200
4	0	2	1	9100	10000	200	200
5	0	2	1	10100	11000	200	250
6	0	2	1	11100	12000	200	250
1	1	1	1	7600	8500	150	150
1	1	2	1	8800	10000	200	200
2	1	1	1	8500	9500	150	200
2	1	2	1	9700	11000	200	250
3	1	1	1	9500	10400	200	200
3	1	2	1	10700	12000	200	250
1	2	1	1	—	10200	—	200
1	2	2	1	10500	12300	200	250
2	2	1	1	—	11100	—	200
2	2	2	1	11400	13300	250	250
3	2	1	1	—	12100	—	250
3	2	2	1	12400	14300	250	300
1	3	1	1	—	11900	—	250
1	3	2	1	12100	14000	250	300
1	3	3	1	13300	16100	250	300
2	3	1	1	—	12800	—	250
2	3	2	1	13100	15000	250	300
2	3	3	1	14300	17100	300	350
3	3	1	1	—	13800	—	300
3	3	2	1	14100	16000	300	300
3	3	3	1	15300	18100	300	350
1	4	2	2	—	17600	—	350
1	4	3	2	17000	19800	350	400
2	4	2	2	—	18600	—	350
2	4	3	2	18000	20700	350	400
2	4	4	2	19200	22900	400	450
3	4	2	2	—	19600	—	400
3	4	3	2	19000	21700	400	450
3	4	4	2	20200	23900	400	500

Pricing Schedule—Integral Motor Discs.

Number of		Initial Fee		Minimum Monthly Fee	
Discs	Pump Units	Non-Cond. Paint	Cond. Paint	Non-Cond. Paint	Cond. Paint
1	1	5300	5600	150	150
2	1	6100	6600	150	150
4	1	8100	9200	150	200
4	2	8700	9700	150	200

Ransburg Electro-Coating Corp.
Indianapolis 7, Indiana

Multiplication Table

Price Work Sheet—No. 2 Process

Quantity

667	1,334	2,001	2,668	3,335	4,002	4,669	5,336	6,003
695	1,390	2,085	2,780	3,475	4,170	4,865	5,560	6,255
960	1,920	2,880	3,840	4,800	5,760	6,720	7,680	8,640
1,220	2,440	3,660	4,880	6,100	7,320	8,540	9,760	10,980
60	120	180	240	300	360	420	480	540
75	150	225	300	375	450	525	600	675
95	190	285	380	475	570	665	760	855
108	216	324	432	540	648	756	864	972
118	236	354	472	590	708	826	944	1,062
13	26	39	52	65	78	91	104	117
38	76	114	152	190	228	266	304	342
164	328	492	656	820	984	1,148	1,312	1,476
195	390	585	780	975	1,170	1,365	1,560	1,755
75	150	225	300	375	450	525	600	675
1,156	2,312	3,468	4,624	5,780	6,936	8,092	9,248	10,404
2,078	4,156	6,234	8,312	10,390	12,468	14,546	16,624	18,702
2,165	4,330	6,495	8,660	10,825	12,990	15,155	17,320	19,485
310	620	930	1,240	1,550	1,860	2,170	2,480	2,790
275	550	825	1,100	1,375	1,650	1,925	2,200	2,475
413	826	1,239	1,652	2,065	2,478	2,891	3,304	3,717
553	1,106	1,659	2,212	2,765	3,318	3,871	4,424	4,977
50	100	150	200	250	300	350	400	450

Multiplication Table for Use with Form No. 12. 7/10/52.

PLAINTIFF'S EXHIBIT SS.

Assignment.

In Consideration of the sum of Five Thousand Dollars ($5000.00); receipt of which is hereby acknowledged, the undersigned Western Electric Company, Incorporated, a New York corporation, hereinafter called Assignor, does hereby sell, assign and transfer to Harper J. Ransburg, H. Gregg Ransburg, Harold P. Ransburg and Edwin M. Ransburg, a co-partnership doing business under the firm name and style of Harper J Ransburg Company, having an office at 1234 Barth Avenue, Indianapolis, Indiana (hereinafter called Assignee), the entire right, title and interest in and to the invention covered by Letters Patent of the United States No. 1,855,869 issued April 26, 1932 to Emerson Pugh for Method of and Apparatus for Coating Articles, together with all the rights and privileges granted and secured thereby and also all claims, demands and rights of action which said Assignor may have against others on account of any past infringement of said patent, with the right to Assignee to sue for and recover in its own name and for its own use and benefit all profits and damages which have accrued or arisen to said Assignor or to which it may be entitled by reason of any such past infringement. This assignment does not convey to Assignee, directly, indirectly or by implication, any interest, license or right of any kind or character under or relating to any invention or patent other than the invention and patent identified above or any claims, demands and rights of action with respect to past infringements, other than those above specified.

The foregoing assignment is subject to:

(a) a non-exclusive non-transferable license which said Assignor hereby reserves for itself, for Companies

of the Bell System, and for its and their successors, to make, use and sell equipment and to use methods and processes, covered by said Letters Patent and reissues and extensions thereof, said license being for the entire term of said patent or patents; and

(b) any and all licenses under said patent or patents which Assignor may have heretofore granted or agreed to grant.

For the purposes of this Assignment:

"Companies of the Bell System" comprise American Telephone and Telegraph Company, Licensee companies of the American Telephone and Telegraph Company, Western Electric Company, Incorporated and the several subsidiaries of each of the foregoing companies.

"Licensee companies" means companies which operate under patent license and service contracts with American Telephone and Telegraph Company to furnish wire telephone communication facilities as a public service in the United States or between the United States and other countries.

"Subsidiaries" are companies the majority of whose stock entitled to vote for the election of directors is controlled by the parent company either directly by legal or equitable ownership thereof, or indirectly through one or more other companies by means of such stock ownership, or partly by such direct control and partly by such indirect control.

The Assignor hereby covenants with Assignee that it will at all times upon request execute and deliver any and all further assignments, documents and papers which may be necessary to perfect the title of Assignee to said Letters Patent subject to the licenses as aforesaid and that if said

Assignee shall at any time desire to secure a reissue of said patent, the Assignor will, so far as it is able so to do, see that all rightful oaths are made and all lawful acts performed which may be necessary for the procuring of such reissue without charge to Assignee, except for reasonable compensation for time and necessary expense.

Signed at New York, New York, this 7th day of April, 1943.

Western Electric Company,
Incorporated,
By W. F. Hosford,
Vice President.

(Seal)

Attest:
(Illegible),
Secretary.

State of New York, }
County of New York. } ss.

On the 14th day of May, nineteen hundred and forty three, before me came W. F. Hosford, to me known, who, being by me duly sworn, did depose and say that he resides at 21 Sagamore Road, Maplewood, New Jersey, that he is vice president of Western Electric Company, Incorporated, the corporation described in, and which executed the foregoing instrument; that he knows the seal of said corporation; that the seal affixed to said instrument is such corporate seal; that it was so affixed by authority of the Board of Directors of said corporation, and that he signed his name thereto by like authority.

Marguerite M. Wholey,
Notary Public.

(Seal)

PLAINTIFF'S EXHIBIT TT.

Agreement.

This Agreement entered into as of the 3rd day of May, 1943, by and between Harper J. Ransburg Company, a co-partnership consisting of Harper J. Ransburg, H. Gregg Ransburg, Harold P. Ransburg and Edwin M. Ransburg, said co-partners having their principal place of business at Indianapolis, Indiana, hereinafter referred to as "Ransburg," and The Brush Development Company, a corporation of the State of Ohio, having its principal place of business at Cleveland, Ohio, hereinafter referred to as "Brush,"

Witnesseth That:

Whereas, said Ransburg is the owner of a certain application for United States letters patent identified as the application of Harold P. Ransburg, Serial No. 366,529, filed November 22, 1940, entitled "Process for Coating Articles" and the said Brush is the owner of a certain application for United States letters patent identified as the application of Charles K. Gravley, Serial No. 318,914, filed January 15, 1940, entitled "Electrostatic Method and Apparatus"; and

Whereas, said applications for letters patent have been found to interfere and an interference in the United States Patent Office was declared on August 13, 1942, as No. 80,369; and

Whereas the parties did enter into a Memorandum Agreement in respect to said applications and interference proceedings under date of September 17, 1942, and a Supplemental Agreement thereto under date of December 27, 1942; and

Whereas, Ransburg is desirous of acquiring certain

rights in and to the application for letters patent of the said Gravley as hereinafter more specifically set forth and described, and upon the following terms and conditions.

Now, therefore, in consideration of One Dollar ($1.00) and other valuable considerations passing between the parties and the mutual covenants and agreements as hereinafter set forth, said parties do hereby agree as follows:

1. Said above-mentioned Memorandum Agreement and Supplemental Agreement thereto are hereby cancelled and terminated by reason of this Agreement and the provisions and terms hereof.

2. In consideration of the payment by the party Ransburg to the party Brush of Seven Thousand Five Hundred Dollars ($7,500.00), receipt whereof is hereby acknowledged, the said Brush does hereby sell, assign and set over to the party Ransburg, by separate assignments, as evidenced by the instruments executed herewith, the entire right, title and interest in and to said application of Charles K. Gravley for letters patent, Serial No. 313,914, filed January 15, 1940, entitled "Electrostatic Method and Apparatus," and letters patent of the Dominion of Canada to Gravley, No. 408,800, granted November 24, 1942, for "Electrostatic Method and Apparatus."

3. In further consideration, the party Ransburg hereby agrees to pay to the party Brush, One Percent (1%) of the total monies received by Ransburg resulting or emanating from any sale or contract made after five (5) years from the date hereof for the manufacture, installation, lease or license of the apparatus or method, as set forth and covered by either of said first-mentioned applications for letters patent of Harold P. Ransburg or Charles K. Gravley, or any letters patent granted thereon, and in respect to which Ransburg shall keep proper books of account and records which shall be open to inspection by Brush at any time during business hours, and make a

written report to Brush accompanied by the payment herein referred to on or before February first covering the said monies received during the preceding calendar year, or fraction thereof.

4. The party Ransburg does hereby grant to the party Brush, royalty free, a non-transferable but exclusive license to manufacture, use or sell apparatus, or practice the methods of the inventions coming within the scope of said applications for letters patent of the said Harold P. Ransburg above identified and the said Charles K. Gravley above identified, or any letters patent, division or reissue granted thereon, and including said Canadian letters patent, limited to the painting, coating, processing and/or sale of piezo-electric crystals and crystal devices, magnetic recording and/or reproducing apparatus employing a magnetic material as a recording medium and parts thereof, without the right to grant sub-licenses, except that (a) Brush shall have the right to grant sub-licenses to its present and future licensees to embody in piezo-electric devices manufactured by such licensees, piezo-electric units purchased as such by such licensees from Brush and coming within the scope of said applications and to use and sell such piezo-electric devices and to sell or otherwise dispose of such piezo-electric units purchased from Brush as repair or replacement parts for piezo-electric devices of licensees' manufacture, and (b) Brush shall have the right to grant to the American Telephone and Telegraph Company its associated operating telephone companies in the United States, Bell Telephone Laboratories, Incorporated, Western Electric Company, Incorporated, and subsidiaries of the foregoing companies, sub-licenses under any patents and reissues thereof that may be granted on the application of Charles K. Gravley above identified or any divisions thereof within the provisions of any licenses granted or

agreed to be granted to said companies by the party Brush.

5. The party Ransburg hereby grants to the party Brush a non-exclusive and non-transferable license, royalty free, to manufacture and use apparatus or methods coming within the scope of the following letters patent and applications for letters patent, or any letters patent, division or reissue thereof which may be granted on said applications, and for the full term thereof, and to include any letters patent related thereto on covering improvements thereon which may be hereafter acquired by Ransburg during the life of this agreement:

U. S. Letters Patent No. 2,247,963, granted July 1, 1941, for "Apparatus for Spray Coating Articles"; filed by Harold P. Ransburg and Harry J. Green;

Canadian Letters Patent No. 408,800, granted November 24, 1942, for "Electrostatic Method and Apparatus"; filed by Charles K. Gravley;

Application for U. S. Letters Patent Serial No. 308,024, filed December 7, 1939, by Harold P. Ransburg and Harry J. Green, for "Method of Spray Coating Articles";

Application for U. S. Letters Patent Serial No. 313,914, filed January 15, 1940, by Charles K. Gravley, for "Electrostatic Method and Apparatus"; and

Application for U. S. Letters Patent Serial No. 366,529, filed November 12, 1940, by Harold P. Ransburg, for "Process for Coating Articles".

6. This agreement shall remain in force and effect during the life of any letters patent, division or reissue resulting from either of said first-mentioned applications for letters patent of the said Harold P. Ransburg or Charles K. Gravley, terminating upon the expiration thereof, other than as provided in Paragraph (5) and shall extend to and be inclusive of the United States, its ter-

ritories, and the Dominion of Canada, and other foreign countries in which letters patent corresponding to the said Gravley application may be acquired, with exception of the United Kingdom of Great Britain and Northern Ireland, the Irish Free State, Australia, New Zealand, British India, Burma, and Aden, and to that end Brush will cooperate in Ransburg's acquiring such foreign letters patent at Ransburg's request and expense. In the event that no letters patent shall be granted on either of the above identified applications, then this agreement shall remain in force for a period of seventeen (17) years from the date of the agreement.

7. This agreement shall extend to and be binding upon the successors in business, heirs or assigns of either party hereto.

In Witness Whereof said parties have set their hands and seals at Indianapolis, Indiana, and Cleveland, Ohio, respectively, as of the date first above set forth.

Harper J. Ransburg Company
By Harper J. Ransburg (LS)
Copartner

The Brush Development Company
By W. R. Burwell
(Corporate Seal) *Chairman of the Board.*

State of Indiana, }
County of Marion. } ss.

On the 25th day of May, 1943, before me personally appeared Harper J. Ransburg, to me known, who acknowledged that he is one of the copartners of the copartnership, Harper J. Ransburg Company above recited, that he executed the foregoing instrument on behalf of said copartnership, and that the same is his free act and deed, individually and as such copartner.

Julia H. Wells,
Notary Public

(Seal)

Commission expires June 20, 1944.

State of Ohio, }
County of Cuyahoga. } ss.

On the 15th day of May, 1943, before me personally appeared W. R. Burwell, to me known, who acknowledged that he is Chairman of the Board of Directors of The Brush Development Company, that he executed the foregoing instrument on behalf of said company, and that the same is his free act and deed, individually and as Chairman of the Board of Directors.

Dorothy Dille,
Notary Public

(Seal)

My Commission Expires Mar. 12, 1944.

PLAINTIFF'S EXHIBIT UU.

This Agreement, made and entered into as of the 26th day of September, 1944, between Harper J. Ransburg Company, a co-partnership, consisting of the following partners: Harper J. Ransburg, H. Gregg Ransburg, Harold P. Ransburg, and Edwin M. Ransburg, having its principal place of business at Indianapolis, Indiana, hereinafter sometimes designated as "Ransburg" and the Behr-Manning Corporation, a corporation duly organized pursuant to the laws of the State of Massachusetts, and having its principal place of business at Watervliet, New York, hereinafter sometimes designated as "B-M".

Witnesseth That:

Whereas, Ransburg is the owner of certain patents and patent applications having to do mostly with the electrostatic propulsion and deposition of liquid particles or particles suspended in liquid, particularly in relation to the painting art, all more particularly set forth in Exhibit A hereto annexed and sometimes mentioned as Ransburg Patents: and

Whereas, B-M is the owner of certain patents and patent applications relating to the art of electrostatic deposition of particles or materials, all more particularly set forth in Exhibit B annexed hereto and sometimes mentioned as B-M Patents; and

Whereas, Ransburg is operating in the field which is broadly defined as the application of liquid coatings; and

Whereas, B-M is operating in the field broadly defined as manufacturing and selling coated abrasives and abrasives and flock coated articles; and

Whereas, it is the desire of Ransburg to grant to B-M an exclusive license under the patents set forth in Ex-

ıibit A in the abrasive and coated abrasive fields and in the field wherein articles are coated with fiber-shaped particles for the life of such patents and the life of any patents that may be issued upon the applications set forth in Exhibit A and for the life of any patents that may issue from re-issues or subdivisions of any such patents or patent applications, and

Whereas, it is the desire of B-M to grant to Ransburg an exclusive license under the patents set forth in Exhibit B in the field of the application of paints or liquid coatings for the life of such patents and the life of any patents that may be issued upon the applications set forth in Exhibit B and for the life of any patents that may issue from re-issues or subdivisions of any such patents or patent applications.

Now, Therefore, in consideration of the premises and of the mutual and reciprocal covenants and agreements hereinafter contained, Ransburg and B-M each for themselves, their successors and assigns, have agreed and do hereby agree as follows:

1. Ransburg hereby grants to B-M an exclusive royalty-free right and license with the right to grant sublicenses under each and every of Ransburg's patents set forth in Exhibit A and any patents issuing from applications set forth in Exhibit A and from re-issues and subdivisions of any such patents or applications, for the life of such patents. Such exclusive license shall apply and be limited to:

(a) Abrasive articles of every kind involving the electrostatic propulsion, dispersion, orientation, deposition, or classification of solid and/or liquid particles;

(b) Flock coated articles or articles coated with fiber-shaped particles of material of every kind in-

volving the electrostatic propulsion, dispersion, orientation, deposition, or classification of liquid particles and/or solid fiber-shaped particles and/or comminuted fiber-shaped particles; and

(c) For the separation, grading, or classification of abrasive or fiber-shaped particles of material used in connection with the fields described in (a) and (b) above, according to kind, size, and/or weight.

2. B-M hereby grants to Ransburg, an exclusive royalty-free right and license with the right to grant sub-licenses under each and every of B-M's patents set forth in Exhibit B and any patents issuing from applications set forth in Exhibit B and from re-issues and subdivisions of any such patents or applications, for the life of such patents, for use in the electrostatic propulsion, dispersion, orientation, deposition, separation, grading, or classification of liquid particles or particles suspended in a liquid except:

(a) Abrasive articles of every kind involving the electrostatic propulsion, dispersion, orientation, deposition, or classification of solid and/or liquid particles;

(b) Flock coated articles or articles coated with fiber-shaped particles of material of every kind involving the electrostatic propulsion, dispersion, orientation, deposition, or classification of liquid particles and/or solid fiber-shaped particles and/or comminuted fiber-shaped particles; and

(c) For the separation, grading, or classification of abrasive or fiber-shaped particles of material used in connection with the fields described in (a) and (b) above, according to kind, size, and/or weight.

3. In event of infringement by others of any letters patent covered by and included in this agreement, the party hereto owning said letters patent shall first have the right to bring suit for infringement and join the other party as co-plaintiff or effect settlement thereof for past infringement at its expense retaining any and all recovery from such suit or settlement, the other party cooperating therein and having the right to be represented by counsel at its expense; provided however that said other party as exclusive licensee under such infringed patent, but only if the infringement extends to and invades its exclusive rights hereunder, shall have the right to bring suit for infringement of said patent and join the owner of the patent as co-plaintiff or effect settlement thereof at its expense, retaining any and all recovery from such suit or settlement, if after six months written notice the owner of the patent fails to proceed with such suit or settlement and wherein the owner of the patent shall have the right to be represented by counsel at its expense, and shall cooperate in such suit or settlement; and provided further that in the event said parties may proceed jointly with the filing of such suit or settlement and share equally in the expense thereof, then said parties shall divide equally between them any recovery therefrom.

4. In event of any question or dispute arising hereunder with respect to the extent or limitations of the respective exclusive fields, as defined in paragraphs 1 and 2, or any interpretation thereof the parties agree that they will use every effort to amicably adjust such question or dispute by conference and agreement between themselves and to endeavor to reach an agreement under such paragraphs, and preferably prior to any commitment thereon. If the parties fail to settle the dispute by conference as stipulated above, such dispute shall be settled by arbitration pursuant to the Arbitration Law of the State

of New York. Either party to such dispute may make a demand for arbitration by notice in writing served upon the other party to the dispute stating the substance of the dispute and the contention of the party making the demand. Within ten (10) days afte rthe service of a demand for arbitration, B-M and Ransburg shall each name an arbitrator and the arbitrators so chosen shall select a third arbitrator. In the event that either B-M or Ransburg fails to comply with the provisions of this paragraph, B-M or Ransburg may make application to the Supreme Court of the State of New York for the enforcement of this paragraph 4. The dispute shall be submitted to the arbitrators in such manner as they shall direct, and the decision of a majority of the arbitrators, rendered in writing, shall be final, conclusive and binding upon B-M and Ransburg. Each party shall pay its own expenses in connection with the arbitration; but the compensation and expenses of the arbitrators shall be borne in such manner as may be specified in their decision in writing.

In Witness Whereof said parties have set their hands and seals at Indianapolis, Indiana, and Troy, New York, respectively, as of the day first above set forth.

Harper J. Ransburg Company
By Harper J. Ransburg
Copartner

Witness
I. Koor

Behr-Manning Corporation
By Elmer C. Schacht
Vice-President

Attest
(Illegible)
Secretary

State of New York,
County of Rensselaer. } ss

On the 24th day of November, 1944, before me personally came Elmer C. Schacht to me known, who being by me duly sworn, did depose and say that he resides in Troy, New York; that he is the Vice President of Behr-Manning Corporation, the corporation described in and which executed the above Instrument; that he knows the seal of said corporation; that the seal affixed to said Instrument is such corporate seal; that it was so affixed by order of the Board of Directors of said corporation, and that he signed his name thereto by like order.

My commission expires March 30, 1945.

L. Paul De Long,
(Seal) *Notary Public*

State of Indiana,
County of Marion. } ss.

On the 13th day of November, 1944, before me personally appeared Harper J. Ransburg, to me well known as one of the copartners of the copartnership, Harper J. Ransburg Company above recited, that he executed the foregoing instrument on behalf of said copartnership, and that the same is his free act and deed, individually and as such copartner.

Nina R. Beauchamp
(Seal) *Notary Public*

My commission expires Mar. 14, 1945.

Exhibit A.

United States Patents:

Pugh 1,855,869
Ransburg 2,247,963
Ransburg 2,334,648
Ransburg 2,270,341
Ransburg 2,335,790

Applications:

Ransburg & Miller—Overspray Recovery for Spray Booth—Ser. No. 516,256—filed Dec. 30, 1943

Ransburg & Helmuth—Method and Apparatus for Coating Articles—Ser. No. 492,204—filed June 25, 1943

Ransburg, Miller & Curtis—Apparatus for Spray Coating Articles—Ser. No. 516,778—filed Jan. 3, 1944

Starkey—Method and Apparatus for Spray Coating Articles—Ser. No. 519,333—filed Jan. 22, 1944

Ransburg—Apparatus and Method for Spray Coating Articles—Ser. No. 519,332—filed Jan. 22, 1944

Ransburg—Electrostatic Coating Method and Apparatus—Ser. No. 540,648—filed June 16, 1944

Miller—Method and Apparatus for Electrostatically Spray Coating Patterns—Ser. No. 540,627—filed June 16, 1944

Ransburg & Curtis—Coating Apparatus—Ser. No. 548,503—filed June 28, 1944

Ransburg & Curtis—Method and Apparatus for Coating Hollow Articles—Ser. No. 542,558—filed June 28, 1944

Exhibit B.

United States Patents:

Re. 20,660
Re. 22,419
1,854,071
2,027,087
2,027,308
2,027,309
2,047,525
2,082,182
2,087,260
2,097,233
2,152,077
2,166,385
2,173,032
2,173,078
2,174,328
2,217,126
2,218,445
2,221,338
2,222,539
2,223,476
2,231,324
2,245,301
2,248,064
2,248,853
2,279,361
2,281,558
2,287,837
2,318,570
2,318,571
2,328,577
2,356,489

Applications

U. S. Appl. Serial No. 391,294
U. S. Appl. Serial No. 396,636
U. S. Appl. Serial No. 541,579 (Division of U. S. Pat. 2,356,489)

The following divisional applications now being prosecuted by the Minnesota Mining & Mfg. Company will not be open for inspection by Ransburg but Ransburg will receive a license under these applications if and when they mature into patents:

U.S. Appl. 200,550 (Division of U.S. Pat. No. 2,248,064)
U.S. Appl. 662,319 (Division of U.S. Pat. No. 2,318,570)
U.S. Appl. 401,484 (Division of U.S. Pat. No. 2,318,570)
U.S. Appl. 452,632 (Division of U.S. Pat. No. 2,318,570)

PLAINTIFF'S EXHIBIT VV.

Agreement made the 7th day of October, 1948, by and between Research Corporation, a corporation organized under the laws of the State of New York and having a principal office at 405 Lexington Avenue, New York 17, New York, (hereinafter called the Licensor), and Ransburg Electro-Coating Corp., a corporation organized under the laws of the State of Indiana, and having a principal office at Indianapolis, Indiana, (hereinafter called the Licensee),

Whereas, the Licensor has the right to grant the within license under the letters patent enumerated in Schedule A hereto attached, hereinafter called the Licensed Patents; and

Whereas, the Licensee owns or controls other letters patent and patent applications pertaining to the electrostatic deposition of coating materials and is engaged in the business of licensing others to practice, and in manufacturing apparatus for practicing, the inventions of such other letters patent and patent applications; and

Whereas, the Licensee is desirous of obtaining a license under the Licensed Patents upon the terms and conditions hereinafter set forth;

Now, Therefore, in consideration of the premises and faithful performance of the covenants herein contained, It Is Distinctly Understood and Agreed:

1. The Licensor hereby grants to the Licensee and the Licensee hereby accepts from the Licensor, upon the terms and conditions hereinafter specified, a license to practice the inventions covered by the Licensed Patents in the country or countries in which the Licensed Patents are effective to the full end of the term or terms for which the Licensed Patents are issued, unless sooner terminated as hereinafter provided.

2. For the rights and privileges granted under the license, the Licensee will pay to the Licensor, in the manner hereinafter provided, to the end of the terms of the Licensed Patents or until this license is surrendered, canceled or terminated as hereinafter provided, earned royalties as follows:

a. Five percent (5%) of the net sales price of apparatus sold by the Licensee and embodying any invention, or adapted and intended for use in practicing any invention, set forth and described in the Licensed Patents, or any of them;

b. Two and one-half percent (2½%) of all sums received by the Licensee as rental for the use of any apparatus embodying any invention set forth and described in any of said Licensed Patents and/or as consideration for the grant of any sub-license under which the sub-licensee practices any invention set forth and described in the Licensed Patents; provided, however, that if any sub sub-licensee operates under sub-license from Licensee a plurality of electrostatic coating units less than all of which embody, or in use

employ, one or more of the inventions set forth and described in the Licensed Patents, Licensee shall not be obligated to pay Licensor any portion of royalties properly allocatable to units which do not embody, and in use do not employ, any invention set forth in the Licensed Patents.

3. The license granted by paragraph 1 above is subject to the following conditions:

a. Notwithstanding anything herein to the contrary, such license is limited to apparatus and methods employing one or more of the inventions of the Licensed Patents in the electrostatic deposition of liquid materials and specifically does not include use of any such invention in connection with flock-deposition, flock-coated material, or in the manufacture of abrasives and coated abrasives.

b. Such license, unless hereinafter modified in accordance with paragraph 7 below, is and shall remain exclusive.

c. Such license, whether or not it remains exclusive, includes the right to manufacture, use, and sell apparatus embodying the inventions of the Licensed Patents and the right to sub-license others both to use the methods set forth and described in the Licensed Patents and to use and sell, but not to manufacture, the apparatus set forth and described in the Licensed Patents, provided, however, that if Licensee grants to any person, firm, or corporation a license effective within the Dominion of Canada Licensee may grant such person, firm, or corporation the right to manufacture, or to have manufactured, in Canada apparatus embodying any invention set forth and described in Licensor's Canadian Letters Patent No. 374,892; provided nevertheless, that such right shall be limited

to apparatus employing one or more of the inventions of the Licensed Patents in the electrostatic deposition of liquid materials and shall specifically preclude any use in connection with flock-deposition, flock-coated material, or the manufacture of abrasives and coated abrasives.

4. Licensee shall keep full, true and accurate books of account containing all particulars which may be necessary for the purpose of showing the amount of royalties payable to the Licensor under paragraph 2 above. Said books of account shall be kept at Licensee's place of business, and said books, at all reasonable times within the period of this license and within one year from any surrender, cancellation or termination of this license, shall be open (insofar, as may be necessary to determine the nature and extent of the Licensee's operations under this license), to the inspection of the Licensor or its duly authorized representatives, who shall be at liberty to make copies of or extracts from said books of accounts.

5. The Licensee within sixty (60) days after the first day of January and July of each year, shall furnish the Licensor a true and accurate semiannual report, giving such particulars of the business conducted by the Licensee during the preceding six (6) months under this license as are pertinent to an accounting under this license. Simultaneously with the making of each such report the Licensee shall pay to the Licensor the royalty shown to be due thereby for the period covered by such report. If the Licensor shall so require such reports shall be made under oath, and shall include any special relevant particulars or technical information which the Licensor may require. The rendering of any report and/or the payment of royalty shown to be due thereby shall not in any event bar, or in any way operate as an estoppel of, the Licensor's rights of examination, inspection and audit, as hereinbefore provided for, nor any

rights or remedies of the Licensor as to any additional royalties which may be found to be due, all of which rights and remedies, it is mutually understood and agreed by the parties hereto, shall survive and shall not be deemed to have been waived by any act or omission on the part of the Licensor.

6. Beginning July 1, 1948, and continuing thereafter so long as the license granted by paragraph 1 above shall endure and remain exclusive, the Licensee shall pay the Licensor minimum royalties at the rate of One Thousand Dollars ($1000.00) per year. To that end, if earned royalties as provided for in paragraph 2 above shall amount to less than One Thousand Dollars ($1000.00) in any twelve-month period terminating with the thirtieth day of June in any year after the year 1948, the Licensee shall accompany the semiannual report next due with payment of such sums as may be necessary to make the royalty payments for such twelve-month period total One Thousand Dollars ($1000.00).

7. At any time after June 30, 1951, either party hereto may convert the license granted in paragraph 1 above from an exclusive to a non-exclusive license by giving the other party six months' written notice of its election to do so; provided, however, that if the Licensor shall elect to convert such license from an exclusive to a non-exclusive license its notice of such election, to be effective, shall be accompanied by payment at the rate of Two Hundred and Fifty Dollars ($250.00) per year for the period beginning with the effective date of conversion of the license and terminating with the expiration of the last-expiring of said Licensed Patents. Conversion from an exclusive to a non-exclusive license at the election of either party shall not relieve the Licensee of its obligation to pay minimum royalties for the period terminating with the effective date of conversion or of its obligation to pay earned royalties thereafter; but such conversion shall relieve the Licensee of its

obligation to pay minimum royalties for the remaining life of the license following the conversion.

8. It is understood and agreed that should the license granted by paragraph 1 above cease to be exclusive and should the Licensor thereafter establish any more favorable rate of royalty under conditions substantially identical with those of Licensee under the Licensed Patents than that charged herein, the Licensor will give the Licensee the benefit of such more favorable rate from and after the date it is established.

9. The Licensee will properly affix to its products produced under this license which are covered by one or more apparatus claims of the Licensed Patents proper statutory patent notices.

10. The Licensor agrees to protect its patents from infringement and prosecute infringers when in its judgment such action may be reasonably necessary, proper, and justified. The Licensee shall have the right, upon written request, to submit questions of infringement to arbitrators to determine whether the Licensee may be irreparably damaged or its interests jeopardized in a substantial manner through failure of the Licensor to sue any party or parties claimed by the Licensee to be an infringer or infringers. If said arbitrators determine that the Licensee may be irreparably damaged or its interests jeopardized in a substantial manner by failure to sue such party or parties, the Licensor will file and prosecute suit against the said party or parties on written agreement of the Licensee to pay the cost of such litigation (including legal fees and other disbursements). The Licensee shall be entitled to any recoveries awarded by way of judgment or costs as a result of such proceedings, provided, however, that if any other licensees under the patents alleged to be infringed shall, prior to the institution of such litigation, agree to share in the costs of the litigation equally or in such other

proportion as the licensees may agree upon, such licensees shall share in the same proportion in the proceeds of the litigation.

11. *a.* If the Licensee shall become bankrupt or insolvent and/or if the business of the Licensee shall be placed in the hands of a Receiver, Assignee, or Trustee, whether by the voluntary act of the Licensee or otherwise, this license shall immediately terminate.

b. Upon any breach of or default under this license by Licensee, the Licensor may cancel this license by thirty (30) days' written notice, specifying the breach or default complained of, by registered mail to the Licensee. Said notice shall become effective at the end of said period, unless during said period Licensee shall cure such breach or default.

12. The Licensee may surrender or terminate this license at any time on three months' notice to the Licensor by completing and executing in detail the statement and affidavit annexed hereto, and returning the same with this license by registered mail to the Licensor.

13. Upon any surrender, cancellation or termination of this license, all unpaid royalties on operations under this license shall accrue and become immediately due and payable and royalties at the rate last paid or payable by the Licensee shall accrue and become immediately due and payable for all operations to such date.

14. The surrender, cancellation or termination of this license shall in no way affect the liability of the Licensee for any sums of money accruing or becoming due or payable prior to the date such surrender, cancellation or termination becomes effective and shall be without prejudice to any rights of the Licensor as respects anything which may occur during the period that this license is in

force or to any right of action or remedy of the Licensor for the recovery of any moneys then due hereunder.

15. Any sub-license granted by the Licensee under this agreement shall survive the surrender, cancellation or termination of this agreement and upon such surrender, cancellation or termination the Licensee shall assign all its right, title and interest therein from and after such surrender, cancellation or termination to the Licensor.

16. This agreement shall inure to the benefit of and be binding upon the successors and assigns of each party hereto; provided, however, that without the consent of the Licensor the license granted by the Licensor herein shall not be assignable by the Licensee apart from its entire business.

17. Any controversy or claim arising out of or relating to this license or breach thereof, shall be settled by arbitration, in accordance with the Rules, then obtaining, of the American Arbitration Association, and judgment upon the award rendered may be entered in the highest court of the forum, state or federal, having jurisdiction.

18. All written notices referred to herein shall be given by registered mail addressed to the last known address of the respective parties.

19. This agreement shall be interpreted in accordance with the laws of the State of New York.

20. If, in any proceeding in which the validity, infringement, or priority of invention of any claim of the Licensed Patent is in issue, a judgment is entered which becomes irrevocable by reason of failure or inability to appeal or obtain further review thereof, the construction placed upon any such claim by such irrevocable judgment shall be thereafter followed not only with respect to such claim but to all claims to which such construction applies, with respect to acts occurring thereafter; and if such irrevocable judgment holds any claim invalid or is adverse to the

patent as to inventorship, the Licensee shall be relieved thereafter of paying royalties with respect to any practice of the invention of the Licensed Patents covered only by such claim or by any other claim of equivalent or broader scope to which such irrevocable judgment is applicable, and of the performance of those other acts which may be required by this agreement only because of such claims; provided, however, that if there are two or more conflicting irrevocable judgments with respect to the same claim, the decision of the higher tribunal shall be followed thereafter, but if the tribunals be of equal dignity, then the decision less favorable to the claim shall be followed in respect to all uses within the territorial jurisdiction of the tribunal rendering such less favorable decision and elsewhere the decisions more favorable to the claim shall be followed until the less favorable decision has been followed by the irrevocable judgment of another tribunal of at least equal dignity. In the event of conflicting irrevocable judgments of the Supreme Court of the United States, the lastest shall control.

In Witness Whereof, the parties hereto have hereunto set their hands and seals and duly executed this license agreement the day and year first above written.

Research Corporation,
J. W. Barker,
President.

Attest:

J. W. Hinkley,
Secretary.

Ransburg-Electro-Coating Corp.,
By. E. M. Ransburg,
Vice President.

Attest:

Gregg Ransburg,
Secretary.

(Seal)

State of New York,
County of New York. } ss:

On the 7th day of October, in the year 1948, before me personally appeared Joseph W. Barker to me known, who, being by me duly sworn, did depose and say that he resides in New Rochelle, N. Y. that he is the President of Research Corporation, the corporation described in and which executed the foregoing instrument; that he knows the seal of said corporation; that the seal affixed to said instrument is such corporate seal; that it was so affixed by order of the Board of Directors of said corporation, and that he signed his name thereto by like order.

Adelaide J. McCormack,
Notary Public, State of N. Y. Reg. No. 386.

My commission expires March 30, 1950.

State of Indiana,
County of Marian. } ss:

On this 5th day of October, in the year 1948, before me personally appeared, E. M. Ransburg to me known, who, being by me duly sworn, did depose and say that he resides in Indianapolis, Indiana, that he is the Vice President of Ransburg Electro-Coating Corporation, the corporation described in and which executed the foregoing instrument; that he knows the seal of said corporation; that the seal affixed to said instrument is such corporate seal; that it was so affixed by order of the Board of Directors of said corporation, and that he signed his name thereto by like order.

Calvin Westerhaus,
(Seal) *Notary Public.*

My commission expires March (illegible).

Schedule "A."

U. S. Patents, Date of Issue and Subject:

No. 2,097,233, October 26, 1937, Electrical Deposition in Pattern Form.

No. 2,221,338, November 12, 1940, Deposition of Material.

Canadian Patent:

No. 374,892, July 5, 1938, Improvements in Electrical Deposition in Pattern Form.

Statement and Affidavit for Surrender or Termination of License by Licensee.

(Under paragraph 12 of annexed license.)

Know All Men By These Presents, that Ransburg Electro-Coating Corp. described in the annexed license and hereinafter known as the Licensee, does hereby surrender and terminate to the annexed license in accordance with the terms thereof, and said Licensee represents, declares and covenants, as follows:

1. That said Licensee has not, under past or present business operations, made use or availed itself of any privilege or license under or because of the annexed license except as follows:

2. That said Licensee has heretofore paid to Research Corporation all royalties due according to the provisions of the annexed license on all operations heretofore or at present being conducted by the Licensee under the annexed license, except the sum of ....., check for which is tendered herewith.

In Witness Whereof, the Licensee has hereunto set hand and seal this ..... day of ..... 19....

Attest:

By .....

President,

.....

Secretary.

State of .....
County of ..... } ss:

On this ..... day of ....., in the year 19 ., before me personally appeared, ...
to me known, who being by me duly sworn did depose and say that he resides in ..... ; that he is the ..... of ..... the corporation described in and which executed the foregoing instrument; that he knows the seal of said corporation, that the seal affixed to said instrument is such corporate seal; that it was so affixed by order of the Board of Directors of said corporation, and that he signed his name thereto by like order.

.....
Notary Public.

PLAINTIFF'S EXHIBIT NO. XX.

Subject: Electrostatic Atomization.

Inventor: W. A. Starkey and E. M. Ransburg.

Discussion:

The usual air operated, air atomizing spray gun has many disadvantages when used as the spray source in conjunction with electrostatic precipitation methods. Such guns supply an atomized spray which is limited in extent, not composed of uniform sized particles, and variable in pattern. All of these features have definite disadvantages in this application. It is the purpose of this invention to describe a new method of atomization for use with electrostatic spraying which does not have these limitations.

Several methods of producing this result are described

herein as possible modfiication of the general principle involved.

In drawing #4307 one modification of the electrostatic atomizer is revealed. Fig. 1 shows a cross section view of the arrangement. A supply trough (2) carrying the paint supply has an elongated funnel shaped as indicated. At the mouth (3) of this funnel there is rigidly fastened a member (1) composed of fine wires wound about a fixed shaped mandrel. The sides of the funnel are the only points in contact with the five wires so that when viewed from below, this arrangement presents the appearance of section A-A. The series of openings thus formed between the wires offer a group of passages through which the coating material can flow down to the lower edge. In this manner one has a uniformly distributed source of material.

This arrangement when held above a charged plate or item will upon application of the field present a source from which the paint can be continuously "deteared." The same action will take place if the article or plate is grounded and the arrangement (1) is charged to a highpotential. The method of charging such an arrangement and the theory of operation is discussed elsewhere in letter patents No. ..... The result of such "detearing" action is that the paint leaves the atomization agent (1) in a fine uniform spray and precipitates on the item under the action of the electrical force. As additional material flows down under the action of gravity it likewise will be electrostatically atomized and applied to the piece to be coated. If the coating material is viscous the supply funnel can be closed and controlled air pressure applied to aid flow down to the "detearing" edge.

Another modification of this same principle is covered in drawing #4309. Herein the material to be sprayed enters the electrostatic atomizer through pipe (1) and its flow into the pipe (3) is controlled by valve (2). Pipe (3),

held horizontally under normal operation, has a series of small circular openings along its length at the bottom side. Attached to pipe (3) and shaped as shown in the drawing is a baffle plate (4). About this assembly and along its entire length is wound a fine wire so spaced that small uniform openings exist between each adjacent turn. Material flowing from the openings in pipe (3) flows by way of baffle plate (4) to and through these openings to lower edge of atomizer and is "deteared" from there continuously onto the item, thus supplying the desired coating.

Another modification of this same principle is shown in drawing #4319. In this modification paint from source is supplied through hose (1) and controlled by hand valve (2) so that it flows into head of atomizer (3) under any desired pressure. This head has a cross-sectional V shape as shown and has a series of fine openings (4) along its lower sharp edge. Paint will issue from these openings to be "deteared" and atomized in the manner described above onto the work as indicated. This simple application can be modified by having small projecting wires or cones (5) and (6) extending in a controlled manner from each opening so that extension or retraction of these members in and out of the hole will permit the amount of material issuing from these holes to be controlled.

Drawing #4320 shows the same principles applied to a vertical hand spray application. The atomizer in this case is broken up into sections so that variations in flow caused by pressure differences due to elevation of these various parts can be regulated. Any of the modifications disclosed in drawing #4319 can be applied in this arrangement.

PLAINTIFF'S EXHIBIT ZZ-7.

Agreement Copy No. 1.

Serial No. 3530.

Ransburg Electro-Spray Agreement.

"This Agreement, entered into this 14th day of June, 1949, by and between Ransburg Electro-Coating Corp., an Indiana corporation, having its principal place of business at Indianapolis, Indiana, hereinafter called "Ransburg", and Eastern Venetian Blind Company, Baltimore, Maryland, hereinafter called "User", Witnesseth That:

Whereas, Ransburg is the owner of, or otherwise has the right to grant licenses under, certain inventions, letters patent of the United States or patent applications pertaining to and covering methods and apparatus used in coating articles with electrostatically atomized and electrostatically deposited coating material, the process so used being hereinafter referred to as "said Process", has acquired much engineering data and experience pertaining to said Process, has designed special equipment therefor and is conducting research in that field; and

Whereas, User desires to use said Process and in so doing to avail itself of the experience gained by Ransburg in this field.

Now, therefore, it is mutually agreed as follows:

1. License: In consideration of the payment by User of the fees herein provided, Ransburg hereby grants to User, subject to and in accordance with all of the terms and conditions of this Agreement and while the same is in effect, the right to use said Process in the coating of venetian blinds and parts therefor with the Equipment furnished by Ransburg herein below described, with one Unit,

as shown in Ransburg's Drawing No. 132203 subject to such changes therein and such further specifications as Ransburg may prescribe, but said right shall not include the use of said Process in the manufacture of abrasive articles, flock-coated articles or articles coated with fiber-shaped particles.

2. Equipment: Ransburg will furnish User two voltage packs and electrical controls, an electrostatic atomizer and insulating support therefor, high voltage lead-in means and such other equipment as Ransburg deems desirable, which will be shipped prepaid to User's plant at Baltimore, Maryland upon request of User. Ransburg will supply replacements, without charge, of any defective parts of said two voltage packs, electrical controls and high voltage lead-in means, except where the defect results from improper use or operation, or negligence of User, and provided User returns such defective parts to Ransburg within thirty days after they become defective. User shall furnish all labor, materials and equipment necessary for the use of said Process except the Equipment to be furnished by Ransburg in accordance with this paragraph.

3. Supervision: Ransburg will furnish supervision necessary to placing said Equipment in readiness for operation. Should Ransburg's supervisor make more than one trip to the plant of User or be delayed there for any cause not chargeable to Ransburg, then for each day of such trip or trips or such delay, User shall pay Ransburg Seventy-Five Dollars and any necessary transportation expenses incurred thereby.

4. Conversion: Ransburg will grant, upon written request by User, the right to use said Process other than as described in Paragraph 1 unless the requested use involves unsafe practices or impractical conditions in Ransburg's opinion or is in conflict with the policies or com-

mitments of Ransburg. Such grant will be valid only when written and signed by Ransburg.

5. Liability: User agrees that Ransburg shall not be liable to User for any claim resulting from the use, operation or condition of the Equipment furnished by Ransburg. User further agrees to reimburse Ransburg for any loss which may be sustained as a result of any liability to third parties for any claim resulting from the use, operation or condition of the Equipment furnished by Ransburg, while said Equipment is in the possession or custody of User.

6. Use of Equipment: User agrees to follow Ransburg's safety recommendations, and to maintain said Equipment in as good repair as when installed, ordinary wear and tear from proper use and operation alone excepted. User agrees that it shall not use or operate said Equipment with any of the parts or safety devices removed, and to reimburse Ransburg for loss of or damage to said Equipment while in User's possession or custody.

7. Title: Title to said Equipment shall at all times remain in Ransburg and said Equipment shall remain personal property regardless of how it is affixed to the realty. Ransburg shall have at all times, during business hours, the right to enter User's premises for the purpose of determining whether said Equipment and said Process are being used as herein provided. User shall not have the right to (1) lease or grant the right to use said Equipment to any person, firm or corporation, (2) remove it from the plant to which it is delivered for installation or (3) use it for any purpose or in any manner other than as herein provided. Upon termination of this Agreement, User agrees to deliver said Equipment, freight prepaid to Indianapolis, Indiana, to Ransburg in as good condition as when installed, ordinary wear and tear incident to its proper use and operation alone excepted.

8. Performance: The performance of Ransburg's obligations hereunder is subject to strikes and lockouts, whether in Ransburg's organization or elsewhere, and to accidents, fire, delays in manufacture or transportation, acts of God, embargoes or any Governmental action as well as any causes for postponement or non-performance over which Ransburg has no control. Any of said causes shall absolve Ransburg from all liability to User for delay or non-performance under the terms hereof.

9. Period of Agreement and Termination: Unless terminated as hereinafter provided, this Agreement shall remain in full force and effect for five years from the date thereof and shall automatically renew itself for successive five-year periods upon the same terms and conditions as those set forth herein.

User shall have the right to terminate this Agreement at any time upon thirty days' written notice to Ransburg, provided User has fulfilled its obligations hereunder and returns said Equipment prepaid to Ransburg within thirty days after such notification, in as good condition as when installed, ordinary wear and tear from proper use and operation alone excepted. Ransburg shall have the right to terminate this Agreement at any time after one year from the original date thereof upon six months' written notice to User.

In the event User shall fail to perform any of the conditions or obligations of this Agreement, and such failure shall continue or recur after written notice thereof from Ransburg, Ransburg may (without prejudice to its rights to recover any amounts owing by User as herein provided or any damages for breach of this Agreement) terminate this Agreement and take possession of said Equipment, and for that purpose permission is hereby given Ransburg, or any of its agents, to enter any premises wherein said Equipment is located, to discover and take possession of

said Equipment without notice and without being liable to any suit, action, indictment or other proceedings by User or anyone claiming under it. Any delay, concession or indulgence on the part of Ransburg in enforcing any of its rights on any default shall not be deemed a waiver of such rights.

10. Fees: User agrees to pay to Ransburg an initial fee of Thirty-five Hundred Dollars ($3500.00) within sixty days after date of shipment of said Equipment or thirty days after date of installation thereof, whichever occurs earlier. User further agrees to pay Ransburg, on or before the tenth day of each calendar month, during the life of this Agreement, a monthly fee of One Hundred Dollars ($100.00) plus twenty percent (20%) of the cost to User of the coating material (including all its ingredients) used in said Unit during the preceding calendar month.

Monthly fees shall not accrue or be payable under this Agreement until the date User begins using said Process in production or until September 14, 1949, whichever date is earlier. The first and last monthly fees payable under this Agreement shall be prorated according to the portion of the month for which they are payable but only to the extent of the first One Hundred Dollars ($100.00) of these fees.

If within ninety days after the date of this Agreement User terminates this Agreement in accordance with the provisions of Paragraph 9, Ransburg will credit User with the initial fee and any monthly fees that have accrued under this Agreement.

In addition to the above fees, User agrees to pay, or to reimburse Ransburg if it should be obliged to pay, directly or indirectly any taxes, licenses, or fees imposed by the laws of any State, of any political subdivision, or any municipality, or of any other governmental authority by reason of the installation, possession, use or location within

the state of any equipment furnished pursuant to this Agreement. Such sums as may be due under this provision shall be paid separately or added to the invoice for other payments as the law may require or as Ransburg may determine.

Upon request of Ransburg, User shall supply Ransburg with a written report showing the monthly quantity of coating material used in said Unit and the cost to User of said coating material. User agrees to keep permanent books of account from which the correctness of said monthly reports can be verified and agrees that such books of account shall be open to inspection by Ransburg or its duly authorized representatives at any time during User's regular business hours.

11. Technical Information: User hereby agrees to exercise reasonable precaution to treat all information relating to said Process or equipment as secret and confidential.

12. Future Inventions: User Agrees that in the event User acquires any inventions, improvements or letters patent, domestic or foreign, relating to electrostatic coating processes or apparatus, or products made by such processes or apparatus, from any source, Ransburg shall have with respect to the manufacture, use and sale of said inventions, improvements and the subject matter of said letters patent, a royalty-free, assignable license, with right to sub-license, such license to be irrevocable except upon voluntary surrender by Ransburg. Ransburg's rights under this paragraph shall extend to all patents acquired by User during the term of this Agreement or within two years thereafter and to all inventions and improvements, made during the term of this Agreement or within two years thereafter, by User or its employees and covered by any patent or patents subsequently acquired by User.

13. Execution of Agreement: This Agreement sets

forth the entire agreement and understanding between the parties as to the subject matter of this Agreement and no statements, conditions or representations, either oral or written, made by the parties, their employees or agents, including conditions or provisions appearing in any purchase order or other instrument issued by User, shall be valid or binding unless contained in a written instrument signed by both parties.

This Agreement is executed by Ransburg in quadruplicate, subject to execution by User and delivery of two executed copies thereof to Ransburg within thirty days of the date first above written; and if so executed and delivered within that time, it shall be a contract, as of said date, between the parties under the laws of the State of Indiana.

All of the rights and privileges of Ransburg hereunder shall be extended to and inure to the benefit of the successors in business or assigns of Ransburg upon User being given written notice of the assignment of this Agreement to such successors in business or assigns and upon such successors in business or assigns accepting and assuming all obligations of Ransburg hereunder in writing.

In Witness Whereof, the parties have executed this Agreement, acting herein by their respective officers duly authorized therefor.

Ransburg Electro-Coating Corp.

By E. M. Ransburg *V. P.*
Ransburg Title

Attest:
Harry E. Downer

.....

By Harry S. Rosenbaum *Pres.*
User Title

Attest:
Morton M. Robinson

PLAINTIFF'S EXHIBIT ZZ-8.

Ransburg Electro-Spray Agreement Serial No. 6148.

This agreement, entered into by and between Ransburg Electro-Coating Corp., an Indiana corporation, having its principal place of business at Indianapolis, Indiana, hereinafter called "Ransburg," and E. I. du Pont de Nemours and Co., Fabrics and Finishes Department, Toledo, Ohio, hereinafter called "User," Witnesseth:

Whereas, Ransburg is the owner of, or otherwise has the right to grant licenses under, certain United States letters patent and inventions pertaining to and covering methods and apparatus used in electrostatically depositing liquid spray particles, the process so used being hereinafter referred to as "said Process," has acquired much engineering data and experience pertaining to said Process, is conducting research in that field, has performed a substantial amount of engineering in adapting said Process to commercial use, has supplied User with some of the results of said engineering pertinent to User's experimental use and has designed special equipment therefor; and

Whereas, User desires to use said Process and benefit from Ransburg's engineering and requests that Ransburg furnish certain special equipment hereinbelow described;

Now, therefore, it is mutually agreed as follows:

1. License: Ransburg hereby grants to User, subject to and in accordance with all of the terms and conditions of this agreement and while the same is in effect, a non-exclusive, nonassignable license to use said Process at User's plant in Toledo, Ohio, with one unit as shown in Ransburg's Drawing No. 231600, subject to such changes therein and such further specifications as Ransburg may prescribe, for testing and matching liquids. It is specifi-

cally understood that the license under this agreement does not give User the right to use said unit for testing the coating of articles for third parties or demonstrating the coating of articles to third parties without Ransburg's consent in writing.

2. Equipment and Supervision: Ransburg will furnish User, for its use of said Process, high voltage apparatus, triple head and disc atomizing apparatus, liquid supply apparatus for such atomizing apparatus, and electrical controls, and such other equipment as Ransburg deems desirable, which will be shipped prepaid to User's aforesaid plant upon request of User. As parts of Ransburg's equipment become defective, User agrees to return prepaid to Ransburg promptly all such defective parts. Ransburg will furnish User, at Ransburg's prevailing standard charges, replacements of any equipment furnished by Ransburg under this paragraph that becomes defective.

Ransburg will furnish supervision necessary for placing its equipment in readiness for operation. Should Ransburg's supervisor make more than one trip to the plant of User or be delayed there for any cause not chargeable to Ransburg, then for each day of such trip or trips or of such delay, User shall pay Ransburg the sum of Seventy-five Dollars and any necessary transportation expenses incurred thereby.

User shall furnish all labor, materials, and equipment necessary for the Use of said Process except the equipment and supervision to be furnished by Ransburg in accordance with this paragraph.

The furnishing of equipment, replacements, and supervision by Ransburg is subject to the availability to Ransburg of the necessary component parts of the equipment and replacements, to prior shipment commitments of Ransburg or elsewhere, and to accidents, fires, delays in manufacture or transportation, acts of God, court injunctions,

or any governmental action, as well as any causes for postponement or non-performance over which Ransburg has no control; and any failure, due to any of such causes, of Ransburg to perform any of its obligations herein set forth shall not be considered a breach of this agreement.

3. Title and Use of Equipment: Title to all equipment furnished by Ransburg including replacements shall at all times remain in Ransburg, and said equipment shall remain personal property regardless of how it is affixed to the realty. Ransburg shall have at all times, during business hours, the right to enter User's premises for the purpose of determining whether its equipment and said Process are being used as herein provided. User shall not have the right, without the written consent of Ransburg, to (1) lease or grant the right to use the equipment furnished by Ransburg to any person, firm, or corporation, (2) remove it from the plant to which it is delivered for installation, or (3) use it for any purpose or in any manner other than as herein provided.

User agrees that it shall not use or operate Ransburg's equipment with any of the parts or safety devices removed, that it shall follow Ransburg's safety and operating recommendations, and that it shall maintain Ransburg's equipment in as good condition as when installed, ordinary wear and tear from proper use and operation alone excepted.

4. Liability: User agrees that Ransburg shall not be liable to User for any loss, cost, expense, or damage resulting from any failure of said process or equipment to function in any particular manner or to electrostatically coat any particular article or assembly or resulting from the installation, servicing, adjusting, presence, use, operation or condition of Ransburg's equipment. Also, User agrees to indemnify Ransburg for any loss, cost, expense, or damage Ransburg may sustain because of any claims by third parties resulting from the installing, servicing, adjusting, presence, use, operation or condition of Rans-

burg's equipment. User shall be liable to Ransburg for any loss of, or damage to, Ransburg's equipment occurring at any time that such equipment is in the possession of User or any of its agents, ordinary wear and tear from proper use and operation alone excepted.

5. Termination: Either party to this agreement shall have the right to terminate this agreement at any time upon giving the other party thirty days' written notice.

After User returns Ransburg's equipment upon termination of this agreement, Ransburg will refund to User the balance of the initial fee paid by User after deducting the following: (a) any expenses incurred by Ransburg as a result of the return of its equipment, (b) the initial cost of that portion of Ransburg's returned equipment which Ransburg considers obsolete or defective, (c) the cost to Ransburg for initial installation and supervision of User's electrostatic unit under this agreement, and (d) the cost to Ransburg for reconditioning the portion of its returned equipment that is not obsolete.

In the event User shall fail to perform any of the conditions or obligations of this agreement, and such failure shall continue or recur after written notice thereof from Ransburg, Ransburg may (without prejudice to its rights to recover any amounts owing by User as herein provided or any damages for breach of this agreement) terminate this agreement and take possession of its equipment forthwith, and for that purpose permission is hereby given Ransburg or any of its agents to enter any premises wherein its equipment is located to discover and take possession of its equipment without notice and without being liable to any suit, action, indictment, or other proceedings by User or anyone claiming under it. Any delay, concession or indulgence on the part of Ransburg in enforcing any of its rights on any default shall not be deemed a waiver of such rights.

After notice of termination of this agreement, User agrees to deliver the equipment furnished by Ransburg, to Ransburg at Indianapolis, Indiana, freight prepaid, in as good condition as when installed, ordinary wear and tear incident to its proper use and operation alone excepted.

6. Fees: User agrees to pay to Ransburg an initial fee of Four Thousand Dollars ($4,000.00) within sixty days after date of shipment of Ransburg's equipment or thirty days after date of installation thereof, whichever occurs earlier. In the event User has not requested shipment of Ransburg's equipment prior to the termination of this agreement, or within six months of the date of Ransburg's acceptance of this agreement, whichever is earlier, one-half of the initial fee shall become due and payable forthwith, and the balance of it shall be due and payable as provided hereinabove.

In addition to the above fee, User agrees to pay, or to reimburse Ransburg if it should be obliged to pay, directly or indirectly, any taxes, licensed, or fees imposed by the laws of any State, of any political subdivision, of any municipality, or of any other governmental authority by reason of the installation, possession, use, or location of any equipment furnished by Ransburg or by reason of the furnishing of any services by Ransburg pursuant to this agreement. Such sums as may be due under this provision shall be paid separately or added to the invoice for other payments as the law may require or as Ransburg may determine.

If User does not request shipment of Ransburg's equipment prior to the expiration of six months after the date of Ransburg's acceptance of this agreement, Ransburg shall have the right, prior to shipment of its equipment, to change the fees and conditions of this agreement to conform to its policy as of the date of such shipment.

During the term of this agreement, the sum set forth in

Paragraph 2 may from time to time be adjusted commensurately with changes, from the value for November, 1950, in the Consumer Price Index, Large Cities Combined, All Items, as determined by the Bureau of Labor Statistics of the U. S. Department of Labor, on the 1947-49 base, or any successor thereto; provided, however, no such adjustment shall be made unless a change of at least ten percentage points has occurred in said index prior to each such adjustment.

7. Future Inventions: User agrees that in the event User acquires any inventions, improvements, or any rights under any letters patent, domestic of foreign, of any of User's employees at their Toledo, Ohio plant, pertaining to methods and/or apparatus for electrostatically depositing liquid spray particles formed by airless atomization (without the use of compressed air), Ransburg shall have with respect to coating methods and apparatus employing said inventions, improvements, and the subject matter of said letters patent, a royalty-free, non-exclusive, assignable license, with right to sub-license, such license to be irrevocable except upon voluntary surrender by Ransburg. Patents subject to Ransburg's rights under this paragraph shall include only patents under which User has acquired rights during the term of this agreement, patents under which User has acquired rights within two years following termination of this agreement, and patents regardless of when User acquired rights thereunder which cover inventions and improvements made within the term of this agreement or within two years following its termination.

8. Execution of Agreement: This agreement sets forth the entire agreement and understanding between the parties as to the subject matter of this agreement, and no statements, conditions, or representations, either oral or written, made by the parties, their employees, or agents, including conditions or provisions appearing in any purchase order

or other instrument issued by User, shall be valid or binding unless contained in a written instrument signed by both parties. Ransburg makes no warranties of any kind, express or implied, except as set forth in this agreement.

All the rights and privileges of Ransburg hereunder shall be extended to and inure to the benefit of the successors in business or assigns of Ransburg upon User being given written notice of the assignment of this agreement to such successors in business or assigns and upon the written acceptance by such successors in business or assigns of all Ranburg's obligations hereunder.

This agreement consisting of four pages is submitted in quadruplicate for execution by User. It shall become a contract only upon its execution and acceptance by Ransburg's home office in Indianapolis, Indiana, and shall be effective under the laws of the State of Indiana.

In Witness Whereof, the parties have caused this agreement to be executed by an authorized officer or person effective as of the date of acceptance by Ransburg set forth below.

(Seal) Executed and accepted by Ransburg this 26th day of April, 1956.

Ransburg Electro-Coating Corp. (Ransburg)

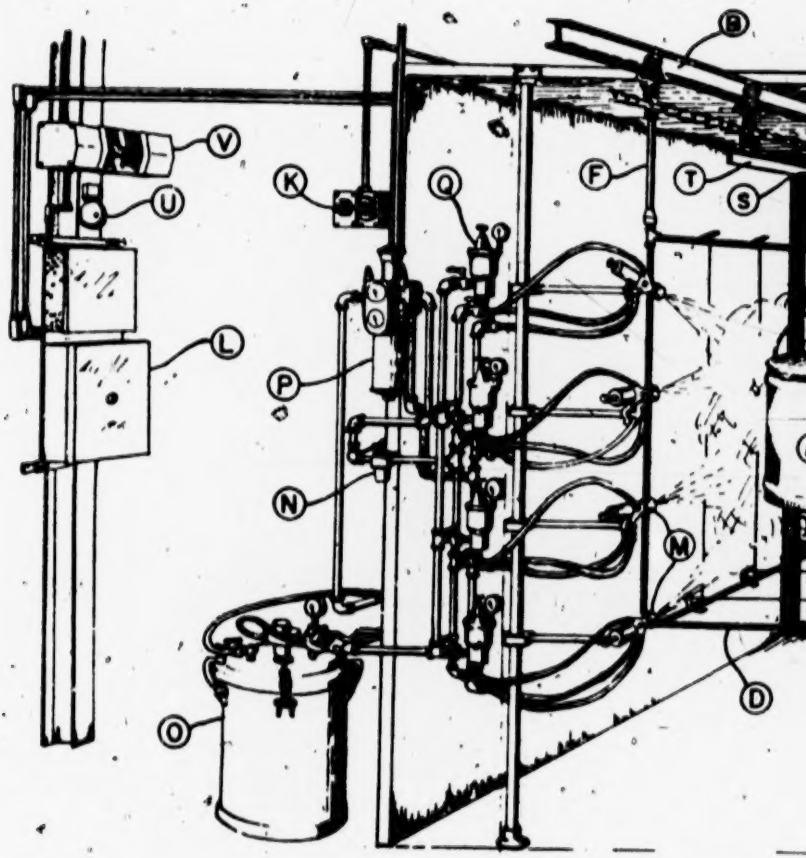
By Harold Ransburg V.P.

E. I. Du Pont de Nemours and Co. (User)

Fabrics and Finishes Department

By W. F. H. Mattlage, *Ass't. Gen. Mgr.*

(Title)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PLAINTIFF'S EXHIBIT GGG.

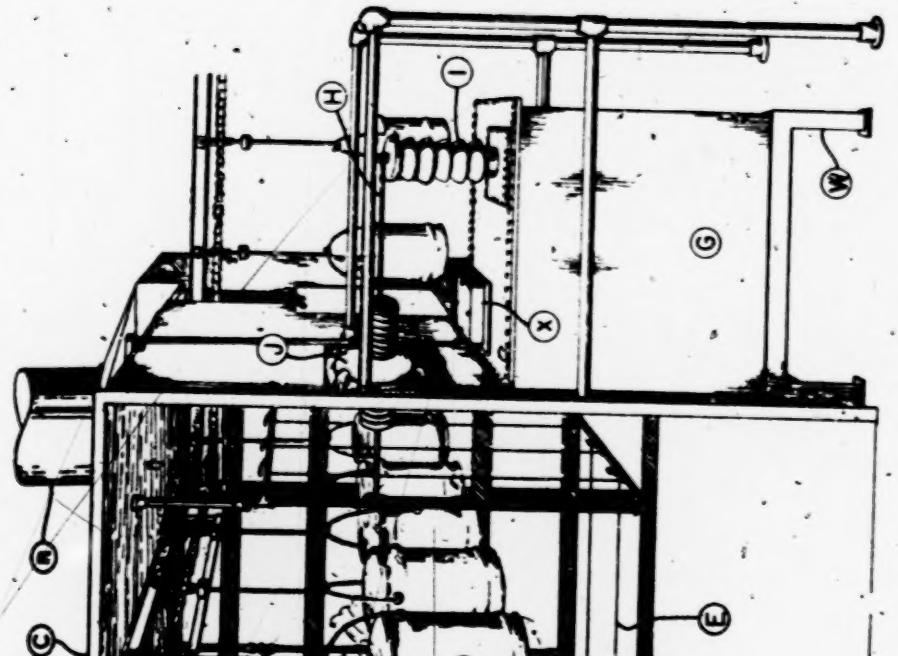


Fig. 1
Typical Installation
Employing Overhead Monorail Conveyor

PLAINTIFF'S EXHIBIT III-1.

Ransburg Electro-Coating Corp.
Indianapolis, Indiana.

June 15, 1954

Sales Bulletin No. 132.

To: RHS EJS MFP GEK GR EPM HEM RO EMR DCH JEM DEC MR HJR

Subject: Pricing Guide For No. 2 Spray Process.

Gentlemen:

The attached is a revised approximate pricing schedule for the No. 2 Process. It has been corrected to be consistent with our current costs and to bring each estimated price nearer to an average condition. Please void or destroy that sent you on May 13.

When using it, please emphasize that it is just a rough approximation. In some cases the final quotation may vary as much as $1000 in either direction, depending on the size of atomizers, the kind of pumps, the number and type of pedestals, etc. Also, it is always possible that the type of equipment required may be quite different after running tests and demonstrations in Indianapolis.

The section headed "Add for Reciprocator" means that this should be added to the initial fee. It has no connection with the cost to the customer for purchasing reciprocators. Our justification for the addition is: (1) We have experienced heavy engineering costs in designing this equipment, (2) after several months we are still searching for a reliable supplier who will take our engineering design and produce the reciprocators on a production basis (to the extent our sales will permit), and (3) a reciprocating

disc will often replace two or more stationary discs, several triple heads, or grouping conveyors, and therefore cost the customers less. It is not contemplated that these reasons or any detailed breakdown of the initial fee should ever be given the customer.

Yours very truly,

Harold.

Harold P. Ransburg.

HPR:eh

Strictly Confidential.

No. 2 Process.

Approximate Pricing Schedule

Triples*	Pumps	Initial	Discs	Pumps	Initial
1	1 (Std)	8,100	1	1	7,500
2	1 (Std)	9,300	2	1	8,200
3	1 (Ins)	11,200	2	2	8,800
3	2 (Std)	11,400	3	3	10,200
4	1 (Ins)	12,200	4	2	10,400
4	2 (Std)	12,500			

If insulated pumps required where standard specified, add $750 for each pump.

Add for reciprocator:
36" or less.....$ 500
Between 36" & 60".... 1000
Above 60" 1500

* For use with single phase triples only.

Definition of a "Unit."

A unit is comprised of that equipment associated with one pack (not more than 4 triples or 4 discs).

Form No. PF54 Rev. A
6-4-54

PLAINTIFF'S EXHIBIT III-3.

Price Work Sheet—No. 2 Process.

Letter to: B. J. Zadoff.
Company Name Grand Sheet Metal Prod. Co.
Date 11-3-54
Address Chicago, Ill. (Melrose Park)
Drawing No. 231039
Product TV and Air Conditoning Cabinets
Figured by DCH Approved

Single Phase Equipment

Atomizing Heads	Qty.	Unit	Ext.
Single Head (Model 121) complete with Pedestal		495	
Triple Head (Model 101)		730	
For each pedestal required add:		112	
For each set tie rods required add:		80	
Atomizing Bells			
(Include one of each size required as a spare)			
2 inch Bell		46	
3 or 4 inch Bell		38	
6 inch Bell		47	
8 inch Bell		60	
10 inch Bell		67	
12 inch Bell		86	
Pump Units			
Standard (Model 105, PIV type) for up to 6 pumps		845	
Insulted (Model 106, PIV type) for up to 12 pumps		1583	
Spare Parts			
Single Head (Model 121)		181	
Triple Head (Model 101)		391	
Pump (105-94), one required for each Pump Unit		29	

Three Phase Disc Equipment

Disc Rotator, complete with Pedestal	2	542	1084
(Include one of each size disc required as a spare)			
8 inch Disc		53	
15 inch Disc		74	
20 inch Disc		165	
25 inch Disc	3	193	579
Pump Unit			
(Model 143 Reeves type) for one or two rotators	2	570	1140
Spare			
Disc Rotator	1	236	236
Pump (105-94) one required for each pump unit	2	29	48
Total			3087
For single phase equipment, add $5500 for each unit*			
For disc, add $5800 for each unit*			5800
If reciprocating, add: for length of stroke 36" or less	$ 500	2	1000
36" to 60"	$1000		
Over 60"	$1500		9887
Total			$9900
Monthly Fee: % of Coating Material Cost			10%
Monthly Fee: Minimum			$ 175

*A unit is comprised of that equipment associated with one park, (not more than 4 triples or 4 discs).

PLAINTIFF'S EXHIBIT III-4.

Special Delivery November 3, 1954
Mr. B. J. Zadoff
Grand Sheet Metal Products Company
2501 West 24th Street
Chicago 8, Illinois

Dear Mr. Zadoff:

We are enclosing two prints of our Drawing No. 231039 showing a proposed layout for two loops for coating your TV and air conditioning cabinets with our No. 2 Process reciprocating disc. The layout we have shown for the loops is merely a suggestion since, of course, the loops may be rearranged in any way so long as the loop diameter is held and so long as the different sides of the cabinets will be sprayed in the proper order. The layout drawing also shows the reciprocator pits. The dimensions of these pits are based on a reciprocator design of our own and might be somewhat different for another design.

As you will recall, both the TV and air conditioning cabinets entered the loop so that one side of the cabinets was coated during the first half of the loop and then the cabinets were indexed 180 degrees and the opposite side coated. After leaving the first loop the cabinets were indexed 90 degrees and the third side was coated in the first half of the second loop and then the cabinets were indexed 180 degrees to coat the fourth side in the second half of the second loop.

The cabinets which we coated during your visit were hung on 42 inch centers and the conveyor speed was 16 fpm. The coating material delivery for the air conditioning cabinets was 180cc per minute for the narrow sides which were coated in the first pass through our loop and 200cc

per minute for the wider sides which were coated in the second pass through our loop. Therefore the total number of air conditioning cabinets obtained per uncut gallon of paint was:

$$\frac{16 \times 12 \times 3785 \times 7}{42 \times 380 \times 4} = 80$$

For the TV cabinets to a total of 400cc per minute of coating material was used (the same delivery was used for all sides). The TV cabinets obtained per uncut gallon of coating material was therefore $\frac{16 \times 12 \times 3785 \times 7}{42 \times 400 \times 4} = 75$

In the above calculation, $\frac{16 \times 12}{42}$ is the number of cabinets per minute, $\frac{3785}{380 \text{ or } 400}$ is the number of minutes required to spray a gallon of reduced material and 7/4 is the ratio to convert the reduced material to unreduced material since the coating material was reduced 4:3.

Our film thickness checks show approximately .6 mil was obtained on both the TV and air conditioning cabinets which we understand is about the film thickness you desire.

We know you will realize a very substantial paint savings over the No. 1 Process with our No. 2 Process disc. We estimate that you will obtain 35% to 40% more cabinets per gallon of coating material with the No. 2 disc and at the same time obtain a much more uniform film.

If it is decided that you will not have a partial panel in the bottom of the air conditioning cabinets as did some of the samples sent to us, then the coating material usage could be reduced for these cabinets by simply not indexing these particular cabinets in the middle of the second loop.

As you will recall, some touch-up would be required around the front of the TV cabinets and around the louvers of the air conditioning cabinets. The insides of both cabinets would require complete coating by some other method.

We are sending you separately an agreement for the use of the No. 2 Process disc in the manner shown on the enclosed drawings. We anticipate that we could deliver our portion of the equipment which includes the voltage supply, fluid pump, controls, atomizing discs, high voltage leads, fluid hose, and support insulators in about three weeks after the agreement is signed. It will be necessary for you to purchase two reciprocators as well as to have your conveyor rearranged in accordance with the enclosed drawings and to provide a shroud for each conveyor loop and ventilation adequate for removing solvent vapors. There is no other spray material to be exhausted.

We anticipate the item which will take the longest time for delivery will be the reciprocators inasmuch as we do not presently have any 36 inch or 48 inch stroke reciprocators in our stock. We know of one firm on the West Coast by the name of Lee Welding & Engineering Company who have provided reciprocators to other Users who quote delivery of sixty days after receipt of the order for a hydraulic reciprocator. Their price for a 36 inch remote control hydraulic reciprocator which will allow the reciprocator stroke to be adjusted without stopping the conveyor line or the reciprocator is approximately $1,600 F.O.B. Los Angeles.

We hope that the enclosed drawings and the above information is sufficient for your requirements, however, if you have any further questions or if you feel we can help you in any way, please contact us or Mr. M. F. Pleva in Western Springs.

I sincerely enjoyed spending part of the day with you, Mr. Koranski and Jim Scavo and hope that I will see you all again in the not too distant future.

Very truly yours,

D. C. Howarth.

DCH:q
cc: Mr. M. F. Pleva.

PLAINTIFF'S EXHIBIT JJJ-2.

Ransburg Electro-Coating Corp.
Indianapolis, Indiana.

July 15, 1953

Pricing Guide for No. 2 Spray Process.

To All Distributors.

The attached is a new pricing schedule showing a slight change in the fees for the No. 2 Process. The prices shown on the attached schedule are intended merely as a guide for making preliminary estimates and no price should be considered as a firm quotation until confirmed by the Home Office.

Similarly to our Bulletin and letters of May 27, 1953, we are now writing all of our No. 2 customers to insure that every customer has been advised that a license can be as readily obtained without equipment, installation supervision, replacement parts and service. We ask that you so advise all of your prospective customers according to the following:

If a customer desires a license without our equipment, the initial fee will be 40 percent of the initial fee shown on the attached schedule. The basic minimum monthly fee

without our equipment is determined by deducting .6 of 1 percent of the standard initial fee (initial fee based on Ransburg supplying equipment) from the standard basic minimum monthly fee. The monthly fee without equipment is determined by deducting .6 of 1 percent of the standard initial fee from the amount that would be paid based on the percentage of the coating material used. The monthly fee which the user pays is, of course, the basic minimum or the amount based on paint consumption whichever is the greater.

Example: Ransburg Supplying Equipment.
Initial fee: $10,000
Basic minimum monthly fee: $230
Monthly fee: 25 percent of the cost of coating material used.

Without Ransburg Equipment
Initial fee: $4,000
Basic minimum monthly fee: $140
Monthly fee: 25 percent of the cost of coating material used, minus $60.

Yours very truly,
E. M. Ransburg.

EMR q

Number 2 Process

Approximate Pricing Schedule

121 Single Heads (1 Pedestal)	Number of Triple Heads	Pump Units	Power Supplies	Initial Fee Non-Cond. Paint	Initial Fee Cond. Paint	Minimum Monthly Fee Non-Cond. Paint	Minimum Monthly Fee Cond. Paint
1	0	1	1	5100	5900	150	150
2	0	1	1	5900	6700	150	150
3	0	1	1	6900	7400	150	150
4	0	1	1	7300	8100	150	150
5	0	1	1	8100	8900	150	200
6	0	1	1	8900	9700	200	200
6	1	1	1	6500	7300	150	150
6	2	1	1	8900	8860	150	200
6	3	1	1	-	11100	-	200
6	3	2	1	11300	12900	250	250
6	4	1	1	-	12500	-	250
6	4	2	1	12800	14600	250	300
6	4	3	1	14200	16300	300	350

140 Single Heads (2 Pedestal)	Number of Triple Heads	Pump Units	Power Supplies	Initial Fee Non-Cond. Paint	Initial Fee Cond. Paint	Minimum Monthly Fee Non-Cond. Paint	Minimum Monthly Fee Cond. Paint
1	0	1	1	5500	6300	150	150
1	0	1	1	6400	7200	150	150
2	0	1	1	7700	8500	150	150
2	0	1	1	8300	9400	150	200
3	0	1	1	9500	10300	200	200
3	0	1	1	10800	11600	200	250
2	0	2	1	10100	11700	200	250
3	0	2	1	11000	12600	200	250
3	0	2	1	12200	13800	250	300

Pricing Schedule

Integral Motor Discs

Discs	Number of Pump Units	Initial Fee Non-Cond. Paint	Initial Fee Cond. Paint	Minimum Monthly Fee Non-Cond. Paint	Minimum Monthly Fee Cond. Paint
1	1	5900	6100	150	150
2	1	6900	7100	150	150
4	1	8900	10100	200	200
4	2	10000	10500	200	200

Form No. PF53

July 15, 1953

PLAINTIFF'S EXHIBIT KKK.

May 27, 1953

General Electric Company
Small Appliance Division
1285 Boston Avenue
Bridgeport 2, Connecticut

Attention: Mr. P. H. Cozier
Manager-Finance
Electric Housewares Dept.

Gentlemen:

This is in reply to your letter dated May 11 to our Mr. John E. Maxwell, regarding our Agreement No. 4806. In addition to a few minor points on the second page, your letter is to the effect that you have two principal objections to the provisions of the subject agreement.

As our Mr. Maxwell has no doubt informed you, the subject agreement form is standard with us, as are the prices quoted therein. We interpret the obligations of the respective parties of an agreement such as this, whether outlined under the paragraph concerning fees or in other paragraphs, as representing the mutual obligations of the parties and if subject matter other than the fee paragraph is modified in a manner preferable to a customer, the fee paragraph should be modified accordingly to insure as nearly as possible equal treatment to our customers.

We are prepared to modify Paragraph 5, entitled Liability, and assume liability to the extent of $100,000 for any damages resulting from our negligence in the manufacture and or installation of our equipment or from inherent defects in such equipment. In order to cover this additional risk, we intend to take out a special insurance

policy. As a result, our monthly fee will necessarily be increased $10.00 per month. This is in conformity with our policy of treating all of our customers as equally as possible.

You also advise that your second principal objection is that in our "Future Inventions" clause we do not provide for paying you any royalties in the event we should wish to use a future development which might be made by you. Your proposed redraft of this clause suggests that we would have the right to use such future invention or inventions made by you "for a reasonable royalty". We are agreeable to amending this paragraph as you suggest, but likewise feel that it is necessary for us in using our best efforts to be equitable to our other customers who do not anticipate charging us for a future development that might be made by them, that we amend our initial fee paragraph in an amount commensurate with the possibilities of necessary payments to you by us or other of our licensees. Accordingly, we believe it would be equitable to change the initial fee from $5300 to $9300.

With respect to "Supervision", it will be appreciated if you will take this letter as assurance from us that trips necessitated by defects in our equipment at the time of the initial shipment or delays occasioned by our representatives will not be chargeable to you. We feel that one point should be clarified in this matter, however, and that is in the event defects result from ordinary wear and tear on the equipment, which defects do eventually develop in most units, and if the replacement parts supplied by us under those circumstances could have been installed by your employees but you desire the presence of one of our employees, we will expect to be reimbursed at the rate of $75 per day including travel time, plus necessary transportation expenses.

We trust that you will take this letter as our assurance that we will not unreasonably object to the removal or transfer of our equipment from your Brockport plant to another plant where you wish to manufacture your food-mixers. We have cooperated with many, many customers in this regard in the past, in fact, in every instance in which we have been requested to do so; but where a customer wishes to make such transfer and desires one of our representatives or supervisory engineers for the reinstallation of our equipment, we have applied the $75 per day service figure.

If, after considering the foregoing, you believe, as we do, that a mutually satisfactory agreement can now be drawn, and you will advise us of your wishes, we shall be pleased to prepare an agreement along the lines suggested above or modified in any other mutually satisfactory manner you desire.

Yours very truly,
Ransburg Electro-Coating Corp.,
E. M. Ransburg.

EMR/mm

PLAINTIFF'S EXHIBIT NO. LLL-1.

Tickler Copy.

March 23, 195

Webster-Chicago Corporation
5610 Bloomingdale Avenue
Chicago 30, Illinois

Attention: Mr. Clarence Wallin
Chief Industrial Engineer

Gentlemen:

We have been advised by our Chicago representative, Mr. Milton F. Pleva, to provide you with information regarding our marketing policies for our No. 2 Electrostatic Disc. These quotations will include insulated pumps since some of your coating material is conducting.

In the case where we supply equipment, our initial fee for a single disc unit would amount to $6100 with a minimum fee of $150 per month or 50% of the cost of the paint used through the unit per month, whichever is greater.

Our initial fee for a set-up including two disc units with one voltage pack and one insulated pump would be $7100. If the two discs had to be operated more than about 20 feet apart, then two insulated pumps would be highly recommended and the initial fee would be $8400. If it was necessary to operate more than 60 feet apart, then two voltage packs would be required and the initial fee would be $10,400. The monthly fee in each case would be $150 minimum (except where the initial fee is $10,400 the minimum monthly fee would be $200) or 50% of the cost of the coating material used through the units, whichever is greater.

We are enclosing a copy of drawing No. 230838 and 230835 for your information. Drawing No. 230838 shows a two disc set-up operating with one voltage pack and two pumps. Drawing No. 230835 shows a disc set-up with one voltage pack and one pump unit. Other variations in lay-out are possible using two discs, and seldom is it necessary to use two voltage packs and two pump units.

If a customer desires a license without our equipment, installation supervision, and replacement parts or service, the initial fees would be 40% of the standard initial fee quoted above. The basic minimum monthly fee or percentage can be accurately quoted after we have determined what size or type installation would be best for finishing your products.

We are enclosing for your information a sample agreement which would apply in the case of Ransburg supplying equipment, installation supervision, replacement parts and service. We believe this agreement is self-explanatory and that it deserves no further comment at this time. However, if you should have any questions pertaining to any phase of the agreement, we will be happy to discuss them with you. For your information, our equipment is not available on the open market, and whereas you could fabricate this equipment it would cost thousands of dollars to manufacture and you would not be guaranteed its functioning properly. We have spent years in developing and engineering this equipment and are constantly striving to improve its operation. You as a customer can capitalize on our experience.

We know from our previous experience with companies finishing parts similar in size to yours—for example, the Standard-Thompson Corporation, Dayton, Ohio; the Sunbeam Corporation, Chicago; the Detroit Hardware Company, Detroit; Enameled Steel & Sign Company, Chicago; and many others—that we can provide you with a saving of about 75% of your present paint bill.

We are certain that we have the most economical means known on the market today for coating your products and are looking forward to being of service to you on this project.

Very truly yours,

Ransburg Electro-Coating Corp.
John E. Maxwell.

EJS/JEM:eh
Enclosures
CC: Milton F. Pleva

PLAINTIFF'S EXHIBIT NO. LLL-2.

May 27,1953

Webster-Chicago Corp.
5610 Bloomingdale Avenue
Chicago 39, Illinois

Gentlemen:

We wish to inquire whether you would like to convert your present electrostatic spray license to one under which we would furnish you no equipment and under which we would assume no obligation for replacement parts, supervision or service, or patent infringement indemnification. If you should elect to assume responsibility for these items for yourself and return our equipment, your basic minimum monthly fee of $100.00 would be reduced to $80.00.

If you are interested in such a proposal, upon advice from you we will send our alternate license agreement.

Yours very truly,

Ransburg Electro-Coating Corp.
E. M. Ransburg

EMR/wn

PLAINTIFF'S EXHIBIT NO. LLL-3.

Webster-Chicago Corporation
Manufacturers of Webcor Products
5610 W. Bloomingdale Ave., Chicago 39, Ill.
Phone Tuxedo 9-8500

June 3, 1953.

Ransburg Electro Coating Corp.,
Barth and Sanders,
Indianapolis 7, Indiana.

Attention: Mr. E. M. Ransburg

Gentlemen:

We are interested in obtaining additional information regarding the conversion of our present electrostatic spray license outlined in your letter of May 27.

Kindly have your Chicago representative visit our plant for further discussion of this subject.

Yours very truly,
Webster-Chicago Corporation
Clarence Wallin
Industrial Eng.

CW/lw

Manufacturers of Diskchangers, Fonografs, Magnetic Records, Dictation Machines, Laminations

PLAINTIFF'S EXHIBIT NO. LLL-4.

Ransburg Electro-Coating Corp.
Indianapolis 7,
Office Correspondence

Date: June 26, 1953

Attention: Mr. E. M. Ransburg

Subject: Webster-Chicago Corp.
Chicago 39, Ill.

Dear Ed:

Reference is made to your letter dated June 11th to which you attached a copy of their letter to us dated June 3, 1953.

I visited Mr. Clarence Wallin and explained the alternate method whereby we would license them to use our Process, they to furnish their own equipment. Mr. Wallin wanted to know the monetary details of this alternate scheme and when I advised him that our basic monthly fee would be reduced from $100 to $80, and that no refund on the initial fee was in the picture, he, of course, lost all further interest. In fact, he wanted to know why we had even bothered to write them concerning such a "ridiculous proposition."

I explained to him that we have always offered our Process either with or without equipment but our records indicated that certain customers had not been advised of this and we were simply trying to give everyone the same opportunity to select whichever proposition they preferred.

The meeting ended amiably with Mr. Wallin convinced that we weren't trying to pull any kind of trick.

Kindest personal regards
Milt

MFP:JP
ss: JE Maxwell

Milton F. Pleva

PLAINTIFF'S EXHIBIT NO. XXX.

Air Mail Special Delivery

June 17, 1955

Westinghouse Electric Corp.
Metuchen,
New Jersey

Attention: Mr. E. J. Murray
Supervisory Buyer

Gentlemen:

In answer to the matters raised in our telephone conversation with you yesterday, we are agreeable to amending the terms of our Electro-Spray Agreement, Serial No. 5826 in the following particulars:

Paragraph 4. Delete "or resulting from any act or omission of Ransburg's employees or agents while on the premises of User" from the end of both the first and second sentences of Paragraph 4.

Paragraph 6. In line 3 of the first subparagraph of Paragraph 6 change "date of shipment" to—date of receipt at User's Metuchen plant—. In the second line of the second subparagraph of Paragraph 6 change "date of shipment thereof by Ransburg" to—date of receipt of Ransburg's equipment at User's Metuchen plant—. It is understood that you will notify us of the date of receipt of our equipment at your plant.

We regret that we cannot accept the amendment which was suggested in reference to Paragraph 3 that Westinghouse does not admit the validity of our patents. It is our policy not to agree that a licensee can contest the validity of our patents and at the same time enjoy the benefits of such patents. We have never given such a concession in

any of our No. 2 Process agreements and in the interest of fair and equal treatment of all our customers we believe it unwise to accept such amendment.

If the foregoing amendments are acceptable to you, kindly sign all four copies of this letter in the space provided below and return two copies of the letter to us with four signed copies of the agreement. I trust that we will be able to move forward to the installation of our equipment in your plant.

Very truly yours,
Ransburg Electro-Coating Corp.
Harold P. Ransburg

HPR:dh
Accepted and agreed to
this ..... day of ....., 1955
Westinghouse Electric Corp.
By .....

PLAINTIFF'S EXHIBIT OOO.

Ransburg Electro-Coating Corp.
Ransburg.
Barth and Sanders Street
Indianapolis 7, Indiana
Telephone: Melrose 2-7513 Cable address: Ranscoat

Mr. Elmer Houlberg
Chicago Rawhide Manufacturing Co.
Elgin, Illinois

Dear Mr. Houlberg:

Mr. John Maxwell has asked me to write you concerning the tests which we conducted for you here in our laboratory. He regrets that he was unable to do this for you before leaving on his vacation but I trust that the information that I will give you will be satisfactory for your needs.

You will recall that here in our laboratory we used our No. 2 type disc equipment for the application of coating material to your seals. In this operation the seals were assembled one on top of the other so as to form a cylindrical group. 24 of the large seals were assembled to a hook and 38 of the small ones were assembled to each hook. This assembly formed essentially a cylindrical item which was then hung from an overhead conveyor on 12" centers. These parts were carried by this conveyor at the rate of 5' per minute into and around a loop in the conveyor which was 4' in diameter. At the center of this loop one of our disc type atomizers which was 15" in diameter was positioned. The disc was tilted at an angle of 20° with the horizontal so as to provide adequate coverage over the entire length of the assemblage. As the parts were carried about the loop they were rotated so as to expose their various sides to the atomized coating material from the disc. This rotation was accomplished by a simple rotating hook which contacted a drag bar as the parts passed around the loop in the conveyor.

The parts which were prepared during your visit were actually carried around the conveyor once and then the process was repeated in order to build up the required coating on the parts. In the case of the large parts, the coating material delivery to the disc was 180 cc's per minute. This material was your green lacquer reduced 1 part of lacquer to ¼ part Butanol, ¼ part Butyl Acetate and ½ part Xylol. Essentially, therefore, the paint was cut 1 to 1 with a thinner composed of the materials recited above.

Since there are 3,785 cc's per gallon of material, we could operate our equipment for 21 minutes on a reduced gallon of material. At a conveyor speed of 5' per minute and 24 parts per hanger we are producing parts at the rate of 120 per minute. Under these circumstances therefore we are obtaining 21 x 120, or 2,520 parts per reduced gallon per

pass about the loop. Since two passes were required to produce the desired film we were obtaining 1,260 parts completely coated per cut gallon of coating material. Since the material was cut in the ratio of 1 to 1 this means that we were obtaining 2,523 parts per uncut gallon of coating material as supplied to us.

The delivery on the small parts was reduced to 100 cc's per minute in order to receive adequate coating. Under these circumstances therefore we could operate for approximately 38 minutes on a gallon of material and since we were obtaining 190 parts per minute, a calculation similar to the above will indicate that we were able to obtain 7,190 completed parts per virgin gallon of coating material.

As was discussed with you during your visit, the installation of our processes in your plant is made on the basis of an initial fee and a monthly license fee. For a single loop unit our initial fee would be $7,300.00. For a double loop unit our initial fee would be $8,500.00. Under both circumstances our monthly fee would be $175.00 or 50% of the cost of the coating material sprayed with this equipment, whichever was the larger. In the case of a single disc installation it would be necessary for you to carry the parts past on the conveyor twice in order to have them receive adequate coating. This could be done by removing every other work hanger from the conveyor and allowing the intermediate ones to pass around the loop a second time. In event that you had two loops, naturally, the operation would take place in a continuous and uninterrupted manner. We would propose to supply to you under the above terms the atomizing discs and their rotators, the fluid pumps for each disc, the high voltage supply and the electrical controls for this equipment. We would also supply such fluid hose and fittings as was necessary for installation. We would also send a man to your plant to supervise the installation of this equipment and train your operators in its use.

So that you will understand the terms under which this equipment is supplied, we are pleased to enclose sample agreements. In event that you decide to proceed with the installation of this equipment, we certainly would be most happy to prepare formal agreements for you and send them to you promptly.

We are having our Engineering Department prepare drawings for you to illustrate the manner in which this equipment could be installed in your plant. In these drawings we are simply showing a single loop with the thought that you could extend this to a 2-loop operation if it is your desire to do so.

We understand that you are going to give some thought to workholders for this particular operation. We want to extend our cooperation to you in this regard. If you have sketches of your ideas for such workholders, we certainly would be most happy to criticize them from the standpoint of our equipment. Actually, if you so desire we would be most happy to try them here in our laboratory to make certain that they will be satisfactory.

We believe that this is an ideal application for our equipment and know that through the use of our processes you would be able to coat these items at considerable savings over other methods which are available to you.

We look forward to working with you on this particular application and trust that you will see fit to contact us if we can serve you further in this connection. Since Mr. Maxwell will be out of the office for approximately three weeks, I trust that you will feel free to contact the writer if you have questions that will arise before that particular time. Mr. Maxwell has asked that I handle this matter for him.

Very truly yours,

Emery P. Miller.

EPM:ab
Enclosures
CC: Milt Pleva

PLAINTIFF'S EXHIBIT PPP.

H. F. Tierney

Purchase Order

No. 100410-134

Chicago Rawhide Manufacturing Company

This number must appear on all invoices, packages, packing slips, shipping papers and correspondence.

Sirvis Mechanical Leather Products
Sirvene Synthetic Rubber Products
Perfect Oil Seals

1301 Elston Avenue, Chicago 22, Illinois
Phone: BRunswick 8-2100

Date
er 11-1-55

Confirming	Terms	F.O.B.	Ship Via	When Ship
XX				

Please send the following and
Charge to Our Account.
Invoice In Triplicate
2 Priced and 1 Unpriced

To Ransburg Electro-Coating Corp.
Barth & Sanders Sts.
Indianapolis 7, Indiana

Attn: Mr. John E. Maxwell

Ship to Same: Dept. 134
900 N. State St., Elgin, Ill.

Chicago Rawhide Mfg. Co.,
Per N. R. Hanson,
Purchasing Agent

☒ For Consumption

☐ For Resale—Applying to Purchases in Illinois Only—Certificate No. 13055

Quantity	Articles	Price
	To cover installation of one unit, Electro-Coating equipment per Ransburg drawing #231349 for electro-statically coating metal oil seals in accordance with Ransburg Electro-Spray Agreement, Serial #5940	
	Installation Cost	$7300.00
	Basic minimum monthly fee	175.00
	Confirms wire 10-20-55 to Mr. D. Howarth	

Wage-and-Hour Law. Your invoices must carry certification that goods were not produced under less than the minimum conditions required by the wage-and-hour law. Invoices not carrying this certification cannot be passed for payment.

Material furnished under this order is subject to our inspection and approval within 10 days after delivery at destination. If materials are rejected, they will be held for disposition at your risk and expense.

By accepting and filling this order, or any part thereof, the seller hereby agrees to, and shall be bound by the terms and conditions printed on the reverse side hereof.

Vendor—Please detach, fill in and return the attached acknowledgment.

PLAINTIFF'S EXHIBIT PPP-2.

H. F. Tierney

Ransburg Electro-Coating Corp.
Ransburg
Telephone: Melrose 2-7513 Barth and Sanders Streets
Cable address: RANSCOAT Indianapolis 7, Indiana

November 4, 1955

Chicago Rawhide Manufacturing Co.
1301 Elston Avenue
Chicago 22, Illinois

Attention: Mr. E. Houlberg

Gentlemen:

We are pleased to acknowledge receipt of four signed copies of Agreement No. 5940. Mr. Harold P. Ransburg has signed this Agreement on behalf of our company and we are returning two signed copies to you herewith.

We note that your purchase order No. 100410-134, dated November 1, 1955, contains provisions which might be considered at variance with, or in addition to, the provisions of our Agreement No. 5940. Inasmuch as this Agreement sets forth the entire contract between us, we assume that you issued such order merely to facilitate your own record keeping and not, in any wise, to modify our Agreement. On that assumption we are returning the acknowledgement copy of the purchase order herewith unsigned and we shall ship our portion of the equipment under the Agreement at a time to be specified by you and your acceptance of the equipment will confirm our assumption that our Agreement No. 5940 is not modified by your purchase order.

We appreciate this opportunity of being of service to you.

Yours very truly,

HED/eh Ransburg Electro-Coating Corp.,
Encls. Harry E. Downer.

PLAINTIFF'S EXHIBIT PPP-3.

PLAINTIFF'S EXHIBIT SSS.

Serial No. 4340

Ransburg Electro-Spray Agreement.

This agreement, entered into this 7th day of April, 1952, by and between Ransburg Electro-Coating Corp., an Indiana corporation, having its principal place of business at Indianapolis, Indiana, hereinafter called "Ransburg," and Hotpoint, Inc., Milwaukee, Wisconsin, hereafter called "User," Witnesseth That:

Whereas, Ransburg is the owner of, or otherwise has the right to grant licenses under, certain inventions, letters patent of the United States, or patent applications pertaining to and covering methods and apparatus used in coating articles with electrostatically atomized and electrostatically deposited liquid coating material, the process so used being hereinafter referred to as "said Process," has acquired much engineering data and experience pertaining to said Process, has designed special equipment therefor, and is conducting research in that field; and

Whereas, User desires to use said Process and in so doing to avail itself of the experience gained by Ransburg in this field and requests that Ransburg furnish certain special equipment herein below described.

Now, therefore, it is mutually agreed as follows:

1. License: In consideration of the payment by User of the fees herein provided, Ransburg hereby grants to User, subject to and in accordance with all of the terms and conditions of this agreement and while the same is in effect, the right to use said Process at User's plant in Milwaukee, Wisconsin, with one unit as shown in Ransburg's drawing No. 230238, subject to such changes therein and such further specifications as Ransburg may pre-

scribe, for electrostatically spraying Water Heater Jackets with Two Units.

2. Equipment: Ransburg will furnish User, for its use of said Process, high voltage, atomizing, and liquid supply apparatus and electrical controls therefor and such other equipment as Ransburg deems desirable, which will be shipped prepaid to User's aforesaid plant upon request of User. Ransburg will furnish replacements, without charge, of any defective parts of its equipment, except where the defect results from improper use or operation or negligence of User, and provided User returns such defective parts to Ransburg within thirty days after they become defective. The furnishing of equipment and replacements by Ransburg is subject to the availability to Ransburg of the necessary component parts of the equipment and replacements and to prior shipment commitments of Ransburg. User shall furnish all labor, materials, and equipment necessary for the use of said Process except the equipment to be furnished by Ransburg in accordance with this paragraph.

3. Supervision: Ransburg will furnish supervision necessary to placing its equipment in readiness for operation. Should Ransburg's supervisor make more than one trip to the plant of User or be delayed there for any cause not chargeable to Ransburg, then for each day of such trip or trips or of such delay. User shall pay Ransburg the sum of Seventy-five dollars and any necessary transportation expenses incurred thereby.

4. Conversion: Ransburg will grant, upon written request by User, the right to use said Process otherwise than as described in Paragraph 1 unless in Ransburg's opinion the requested use involves unsafe practices or impractical conditions or is in conflict with the policies or commitments of Ransburg. Such conversion shall be made only after Ransburg has agreed thereto in writing.

5. Liability: User agrees that Ransburg shall not be liable to User for any claim resulting from the use, operation, or condition of the equipment furnished by Ransburg. User further agrees to reimburse Ransburg for any loss which may be sustained as a result of any liability to third parties for any claim resulting from the use, operation, or condition of the equipment furnished by Ransburg while said equipment is in the possession or custody of User.

6. Use of Equipment: User agrees to follow Ransburg's safety and operating recommendations and to maintain Ransburg's equipment in as good condition as when installed, ordinary wear and tear from proper use and operation alone excepted. User agrees that it shall not use or operate Ransburg's equipment with any of the parts or safety devices removed and to reimburse Ransburg for loss of or damage to Ransburg's equipment while in User's possession or custody.

7. Title: Title to all equipment furnished by Ransburg shall at all times remain in Ransburg, and said equipment shall remain personal property regardless of how it is affixed to the realty. Ransburg shall have at all times, during business hours, the right to enter User's premises for the purpose of determining whether its equipment and said Process are being used as herein provided. User shall not have the right, without the written consent of Ransburg, to (1) lease or grant the right to use the equipment furnished by Ransburg to any person, firm, or corporation, (2) remove it from the plant to which it is delivered for installation, or (3) use it for any purpose or in any manner other than as herein provided. Upon termination of this agreement, User agrees to deliver the equipment furnished by Ransburg, freight prepaid, to Ransburg at Indianapolis, Indiana, in as good condition as when installed, ordinary wear and tear incident to its proper use and operation alone excepted.

8. Performance: The performance of the obligations of both parties hereunder is subject to strikes and lockouts, whether in the organization of either party or elsewhere, and to accidents, fires, delays in manufacture or transportation, acts of God, embargoes or any governmental action, as well as any causes for postponement or non-performance over which the parties have no control; and any failure, due to any of such causes, of either party to perform any of its obligations herein set forth shall not be considered a violation of this agreement.

9. Termination: User shall have the right to terminate this agreement at any time upon thirty days written notice to Ransburg, provided User has fulfilled its obligations hereunder and returns Ransburg's equipment prepaid to Ransburg within thirty days after such notification in as good condition as when installed, ordinary wear and tear from proper use and operation alone excepted. Ransburg shall have the right to terminate this agreement at any time after three years from the date hereof upon six months' written notice to User.

In the event User shall fail to perform any of the conditions or obligations of this agreement, and such failure shall continue or recur after written notice thereof from Ransburg, Ransburg may (without prejudice to its rights recover any amounts owing by User as herein provided or any damages for breach of this agreement) terminate this agreement and take possession of its equipment, and for that purpose permission is hereby given Ransburg or any of its agents to enter any premises wherein its equipment is located, to discover and take possession of its equipment without notice and without being liable to any suit, action, indictment, or other proceedings by User or anyone claiming under it. Any delay, concession, or indulgence on the part of Ransburg in enforcing any of

its rights on any default shall not be deemed a waiver of such rights.

10. Fees: User agrees to pay to Ransburg an initial fee of Fifteen Thousand Dollars ($15,000.00) within sixty days after date of shipment of Ransburg's equipment or thirty days after date of installation thereof, whichever occurs earlier. In the event User has not requested shipment of Ransburg's equipment prior to the termination of the agreement or within six months of the date of this agreement, whichever is earlier, one-half of the initial fee shall become due and payable forthwith and the balance of it shall be due and payable as provided hereinabove. User further agrees to pay Ransburg, on or before the tenth day of each calendar month during the life of this agreement, a monthly fee equal to 10% of the cost to User of the coating material (including all its ingredients) used in said unit during the preceding month, but in no event less than One Hundred Dollars per unit ($100.00), which amount is due in any event and is hereinafter referred to as the basic minimum monthly fee.

Monthly fees under this agreement shall start with the date of installation of Ransburg's equiment or thirty days after the date of shipment thereof from Ransburg's plant, which ever occurs earlier, and the first payment shall be made on or before the tenth day of calendar month following. For the first and last payments of monthly fees under this agreement, the basic minimum monthly fee of One Hundred Dollars ($100.00) shall be prorated according to the portion of the month for which it is payable.

In addition to the above fees, User agrees to pay, or to reimburse Ransburg if it should be obliged to pay, directly or indirectly any taxes, licenses, or fees imposed by the laws of any State, of any political subdivision, of any municipality, or of any other governmental authority by reason

Indianapolis, Indiana, and effective under the laws of the State of Indiana as of the date first above written.

In Witness Whereof, the parties have caused this agreement to be executed as of the day, month, and year first above written.

Hotpoint, Inc.,
By W. R. Grand,
Vive President (Title).

Accepted at the Home Office in Indianapolis, Indiana, Ransburg Electro-Coating Corp. (Ransburg).

By E. M. Ransburg,
(Title) (Illegible.)

(Seal)
dh

Form No. 430.

Amendment to Ransburg Electro-Spray Agreement
Serial No. 4340.

A certain agreement, known as the Ransburg Electro-Spray Agreement, bearing Serial No. 4340, entered into on the 7th day of April, 1952, by and between Ransburg Electro-Coating Corp. and Hotpoint, Inc., is amended as follows:

Delete Paragraph 11 as printed and substitute therefor the following:

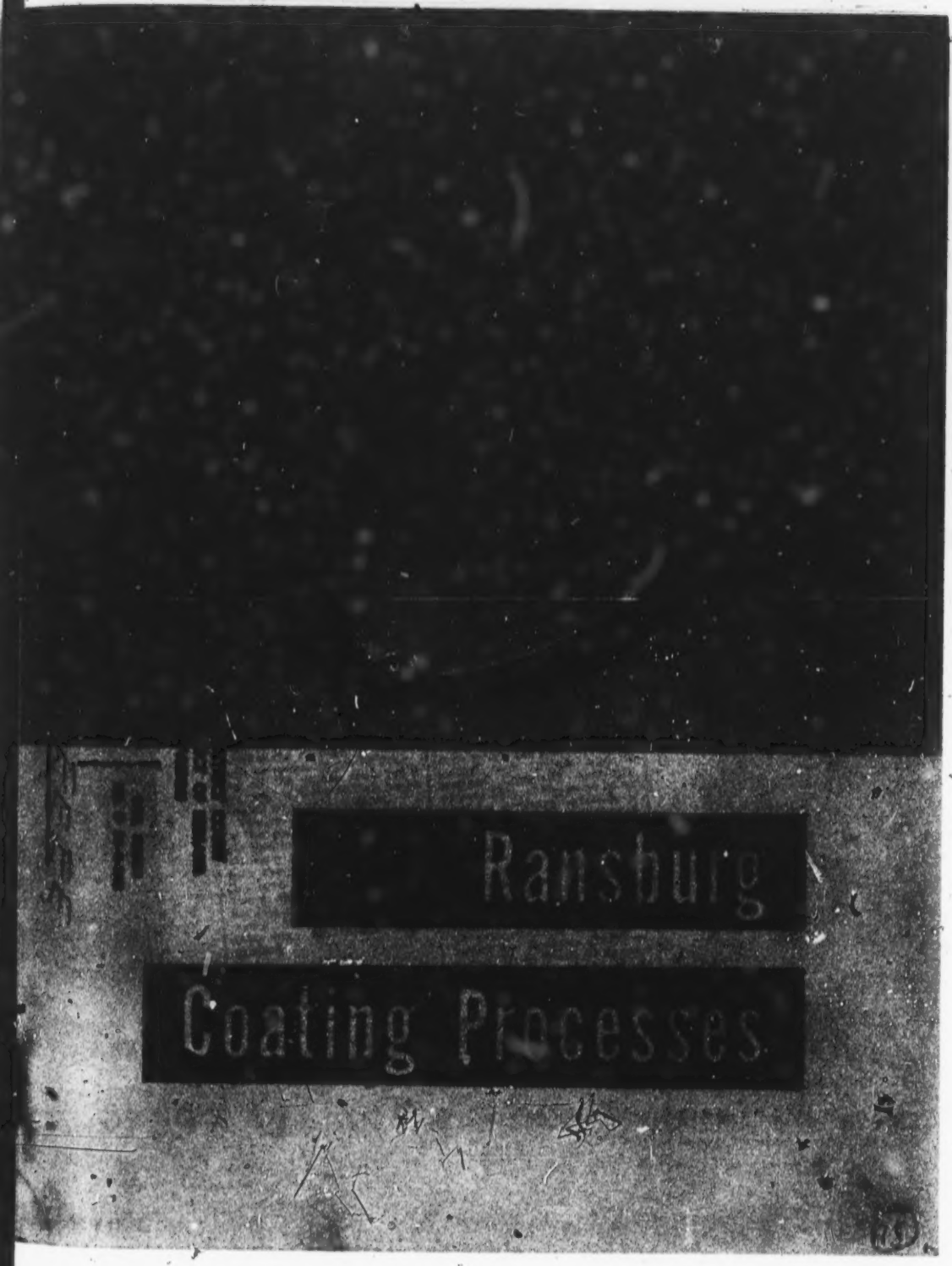
11. Future Inventions: User agrees that in the event User acquires, from its employees, title to any inventions, improvements, or United States Letters Patent, relating to improvements or modifications of methods and/or apparatus covered by Ransburg's Drawing No. 230238 or relating to improvements or modifications of the apparatus or mechanical equipment supplied User by Ransburg pursuant to the terms of this agreement, User shall disclose such inventions and improvements to Ransburg and grant Rans-

burg with respect to such inventions, improvements, and the subject matter of such Letters Patent, upon Ransburg's request and for a reasonable royalty, a non-exclusive license with the right to sub-license, such license to be assignable only with the good will and business of Ransburg in apparatus or method of the character covered by this agreement, and irrevocable except on voluntary surrender by Ransburg or failure by Ransburg to comply with the terms thereof. Patents subject to Ransburg's rights under this paragraph shall include only those acquired by User on said inventions or improvements conceived during the term of this agreement or within one year after the expiration thereof.

In Witness Whereof, the parties have caused this Amendment to be executed as of this 7th day of April, 1952.

Hotpoint, Inc. (User),
By W. R. Grant,
Vice President (Title),

Accepted at the Home Office in Indianapolis, Indiana,
Ransburg Electro-Coating Corp.,
By E. M. Ransburg,
Vice President (Title).


Ransburg
Coating Processes

BUSINESS

By Roger Budrow

Invention of Indianapolis Man Revolutionizing Painting Methods

Electricity has become industry's super paint brush. Combined with the usual dipping or spraying process found in most factories, it does a better job with less labor and much less paint. The discovery, made by an Indianapolis man, was put to some use during the war but now, with the return of price conscious competition, it is spreading rapidly.

The principle is the one familiar to students of high school physics: unlike charges attract each other, like charges repel.

Put into practice, this principle makes the multitudes of tiny paint pellets, shot from the spray gun, go right to the object they're aimed at, with relatively few misses. They'll even go around a corner.

The repelling phase comes into use when articles are painted by dipping. It forces such an excellent job of draining off the excess that you'll see none of those telltale paint "tears" or wrinkled edges.

The method was discovered in the prewar period by Harold Ransburg, now 36, who was working at his father's factory the Harper J. Ransburg Co. here in Indianapolis. He was in charge of painting such household items as bread boxes, cooky jars, trays, cannister sets, etc., the firm's major products.

Worried by Waste

Disturbed by the amount of paint being wasted, Harold Ransburg, who had no technical knowledge, began reading up on electrical [illegible] trodes which have enough attraction to pull off the excess "tears" and fatty edges.)

Saves Much Paint

Although he became interested in seeking a new method of painting primarily to save money for the Ransburg firm, Harold Ransburg quickly saw the potentialities of his discovery. But the war slowed its introduction.

However, word about the results where the process was installed soon spread. And no wonder. Generally speaking, 40% to 50% of the paint being used by ordinary methods is saved, although this has ranged as low as 25% and as high as 80%. Labor needs are reduced. One unit replaced fourteen men at one factory and the quality of the paint job is improved.

Among the firms already using the method are Reliance Steel, R. C. A., General Motors, Chrysler, General Electric, International Business Machines, Servel, U. S. Steel, Bridgeport Brass, Iron Fireman, White Motors, Wheeling Steel and many others.

819

These advantages of the Ransburg Electrostatic Spray Process produce reductions in finishing costs:

Normally 40 to 60 per cent, sometimes as much as 75 per cent.

Fully automatic—requires only one attendant who often can perform other duties. Booth clean-up reduced as much as 75 per cent.

Consistently *uniform* results. Rejects reduced.

Coats equally well at all practical conveyor speeds.

One compact unit often replaces several booths.

Far less exhaust requirements—conserves factory heat.

Results tell the Story...

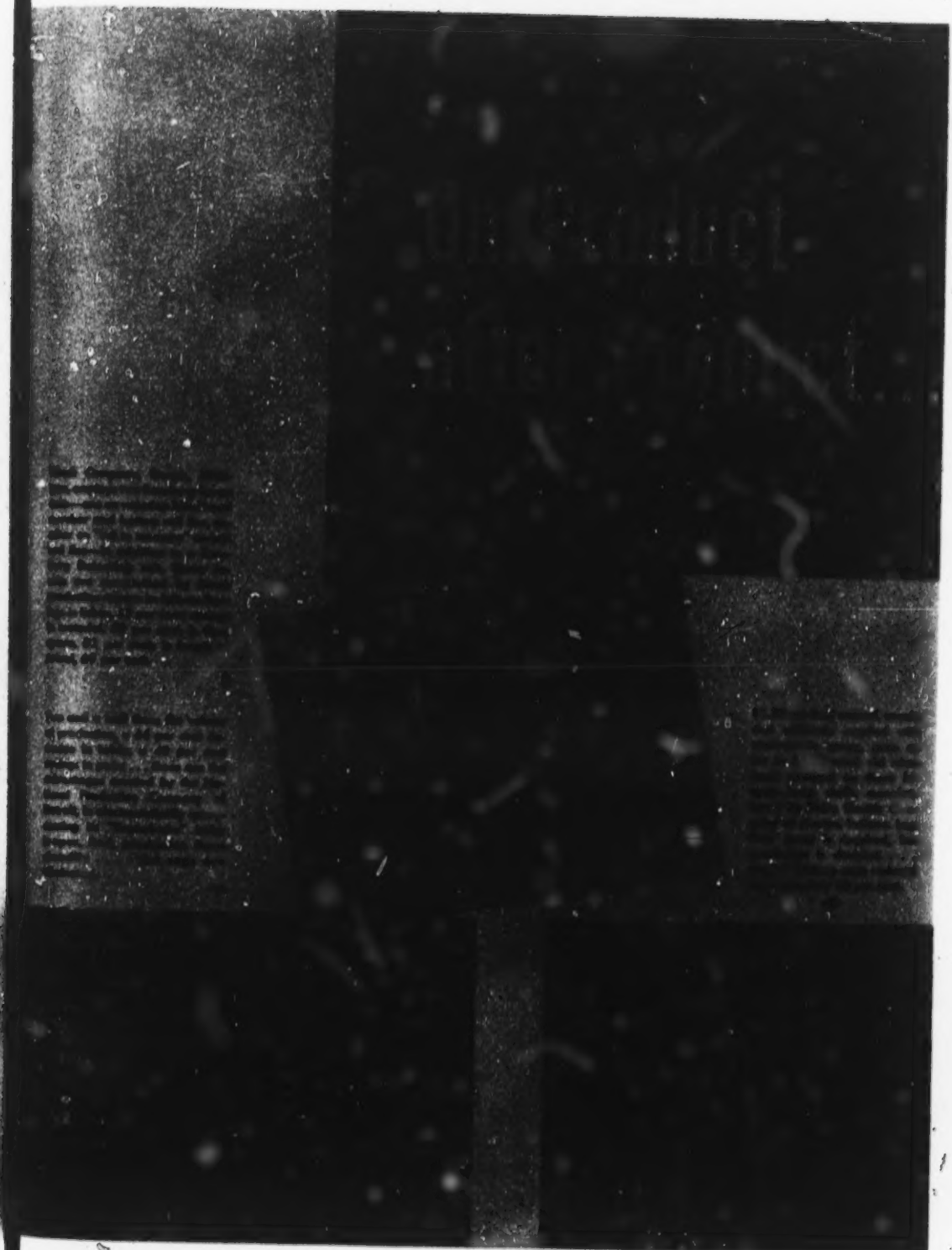
These are only a few of the many applications where important savings in labor, materials, time and rejects have been effected by the Ransburg Electrostatic Spray Process.

In these, as in other Ransburg installations, savings of coating material alone run from 40 to 60 per cent—with far fewer rejects. Labor savings have been as high as 94 per cent.

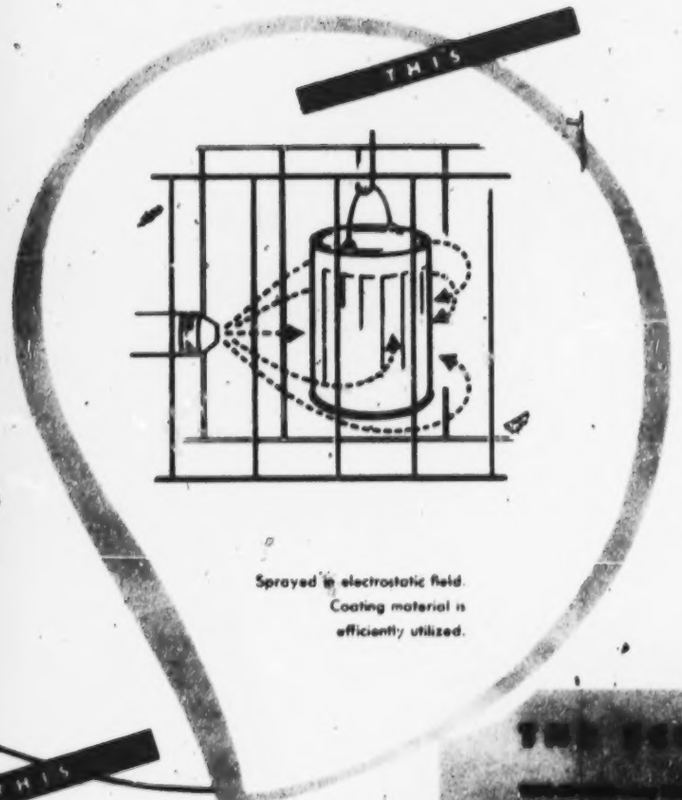
Actual production records like these substantiate the efficiency and economies of Ransburg Electrostatic Spray.

on Job after Job . . .

and . . .



How Electrostatic Spray Works



Sprayed in electrostatic field. Coating material is efficiently utilized.

Ordinary spray methods. Overspray wastes up to 65% of material.

■ Why do you get a coating that is just as heavy, but far more uniform and using 40 to 60 per cent less paint, with the Ransburg Electrostatic Spray Process? Because electrostatic forces, not high operating air pressure or the human element, control the application.

Articles to be coated are supported on workholders carried on a conveyor and are thus moved in endless procession through the spray booth. In the booth, the Ransburg electrode of fine wires is arranged on each side of the conveyor. Automatic spray guns are located at the face of the booth to spray the coating material into the booth in a direction roughly parallel to the path of travel of the articles.

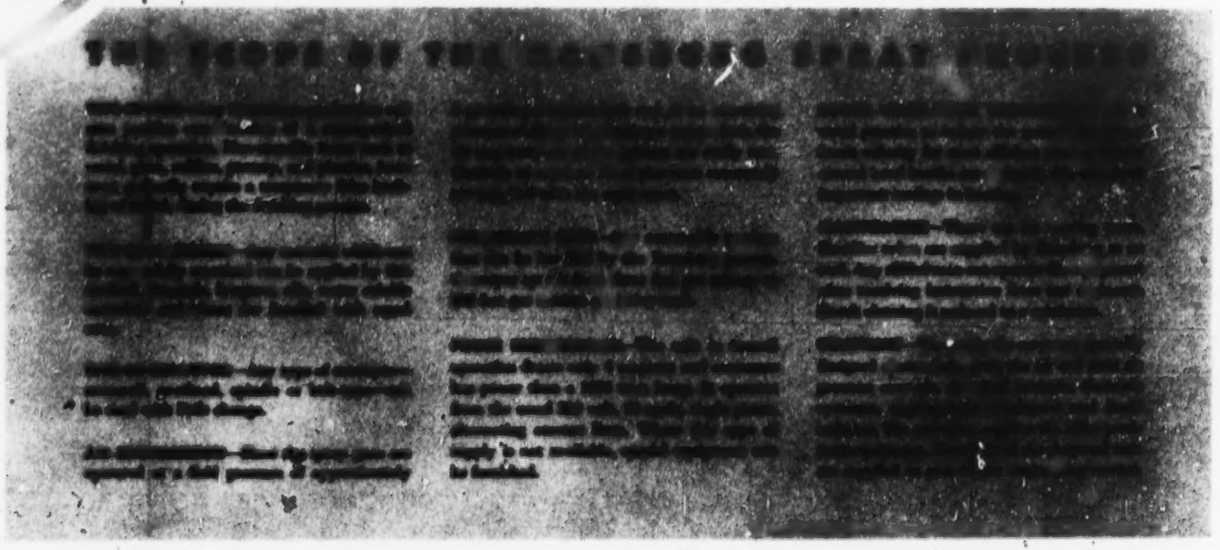
Electrostatic deposition is accomplished by charging the fine wire electrode system to a high potential so that an electrostatic field is created between the electrodes and the grounded articles. Then, as the atomized coating material is sprayed into this field, the particles receive a negative charge and are attracted to the opposite polarity—the line of grounded articles.

The attraction in the coating zone is so great that some of the paint particles even reverse their direction, turning as much as 180 degrees, thus coating more than the facing surface of the articles. This feature is termed "wrap-around" and accounts for the uncanny ability of the process to coat edges and other areas so difficult and costly to cover with hand spray or old mechanical methods.

The sprayed material is directed down the line of articles and is attracted to them by the compelling forces of the electrostatic field. Very little coating material escapes beyond the electrode system. Overall efficiency is high. "Overspray" is put to work, so that it no longer occurs in the normal sense, and thus the phenomenal savings in coating material are accomplished!

There is no limit to conveyor speed so far as the Ransburg process is concerned and any desired increase in production is accomplished simply by introducing the proper amount of material into the electrostatic field. Thus, the labor saving becomes evident—Ransburg equipment requires only the part-time attention of one operator, regardless of the production volume desired!

In addition to material and labor savings, the more uniform film thickness of the electrostatically deposited coating tends to improve appearance and increase wearability and resistance to chipping or marring.

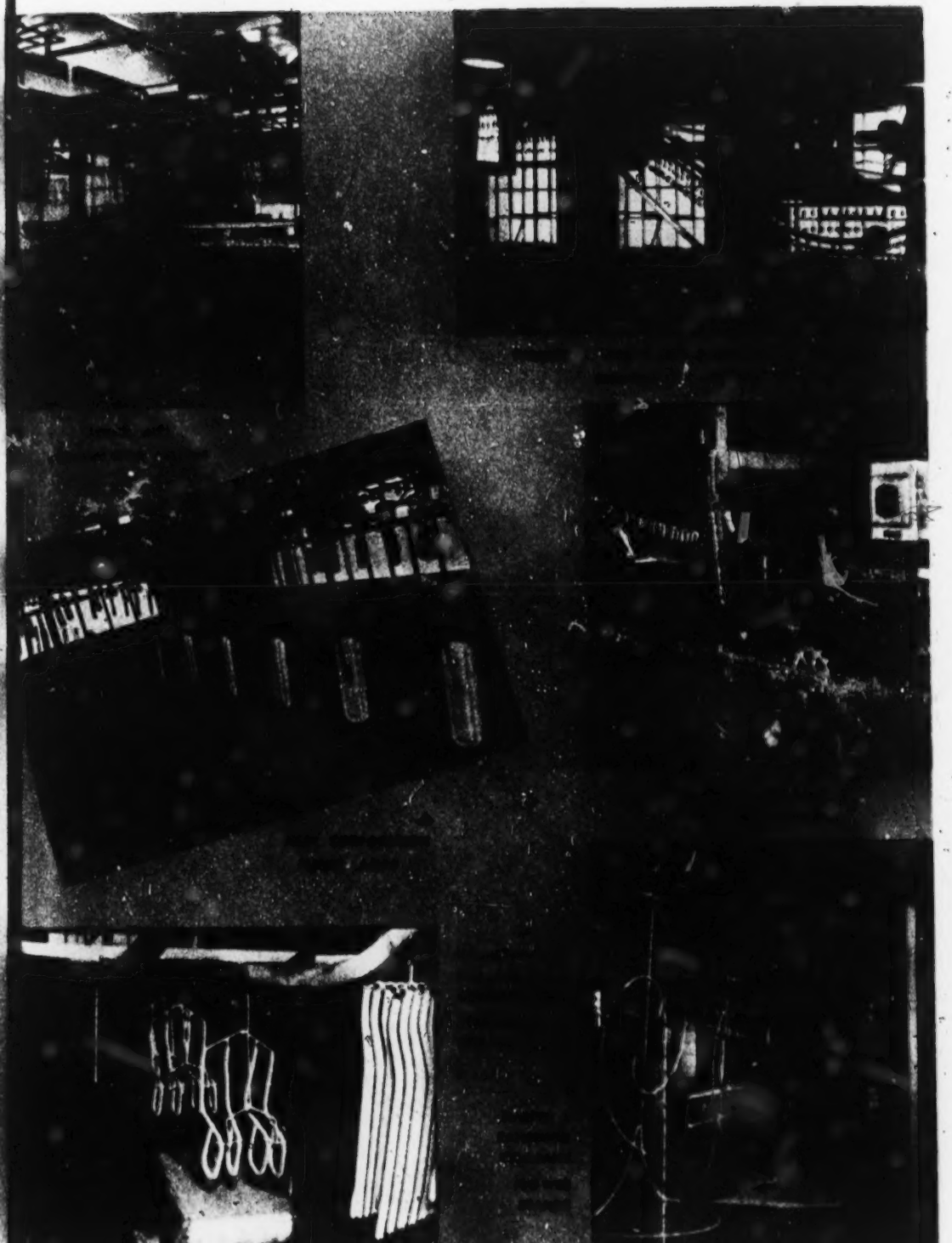


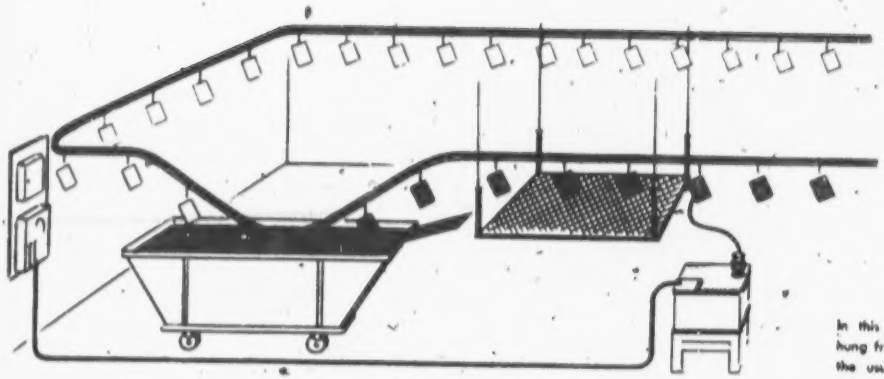
Electrostatic Detearing

The Ransburg Electrostatic Detearing Process offers a positive means of quickly removing accumulated excess paint, tear drops and fatty edges resulting from the use of dipping or flo-coating methods of applying finishes.

Electrostatic detearing has solved scores of coating problems where precision painting or final appearance are stringent specifications.

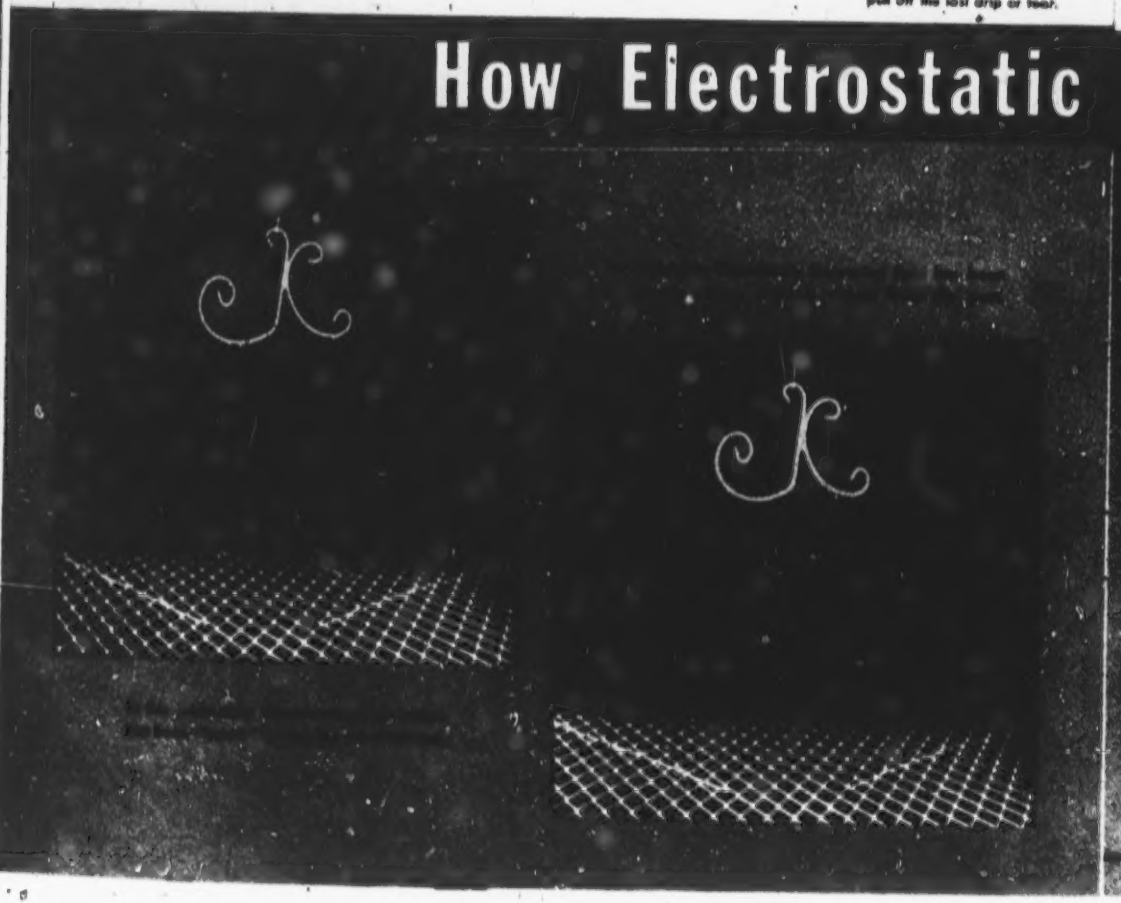
In industry today, the Ransburg Detearing Process is setting new quality standards and adding new sales appeal to many articles—at lower cost with increased production—from aerosol bombs to refrigerator shelves.





In this process the articles are hung from a conveyor, dipped in the usual manner, then carried over a drainboard, which returns the major part of the excess paint to the tank. After a suitable air-dry period, the articles pass over the electrostatically charged detearing electrode, which exerts an attractive force sufficient to pull off the last drip or tear.

How Electrostatic



Detearing Works

The Ransburg Electrostatic Detearing Process is based upon the same principle—electrical attraction of opposite charges (+ and − polarity)—as the Ransburg Spray Process. The action, however, is in the reverse direction, in that this process automatically *removes* the excess coating or fatty edges at drain-off points as the coated article is passed adjacent to an electrostatically charged grid or plate.

The Ransburg Electrostatic Detearing Process is employed when the coating material is applied by the dip or flo-coat method, which causes accumulation of excess material at the drain-off points. The dipped article is carried over a drain board; and when it has finished draining and "tears" or fatty edges remain, it is passed over or between the Ransburg grids of expanded metal, which are maintained at high electrical potential by the special Ransburg equipment. The resultant attraction effectively removes this excess material—in fact, quality equivalent to spray coating can be achieved in many cases.

The time allowed for drain between the dip operation and the electrostatic detearing grid depends upon the shape and size of the articles, the flowing characteristics of the paint, and the evaporation rate of its solvents. Usually, this falls within a time range of 1 to 3 minutes.

Normally, the articles must be subjected to the detearing action for 15 to 30 seconds. Superior results are obtained when the drain-off point is ¼" or less in radius and can be exposed to the electrostatic forces of the detearing grid.

The process is especially desirable where a smooth appearance is desired, or to minimize soft paint films, wrinkles, or chipping from excessively coated edges.

Improved quality is only one of the advantages gained with electrostatic detearing. Complicated work holders which are slow to load sometimes can be abandoned. There is no necessity to conceal the remaining tear or fatty edge when you can remove it with electrostatic detearing.

Faster work cycles often result. In addition, one coat often replaces two when electrostatic detearing is employed. Paints of lower viscosity with faster evaporating solvent can often be used to improve one-coat hiding.

How Ransburg Works With You

■ Each application is individually engineered. Details are worked out in the Ransburg laboratory in test runs simulating actual production conditions, which you are invited to witness. Here are the various steps and services:

SURVEY: Ransburg engineers collaborate with you in analyzing the possible advantages through your use of our electrostatic coating processes in your plant. Of initial interest is type of item or items to be coated; production volume desired; type of coating material, and any special problems. When this preliminary analysis warrants a more thorough survey, we will recommend that samples of your products be sent to Indianapolis.

LABORATORY TESTS: Your product is then test-coated in the Ransburg completely equipped laboratory—using your coating materials. Different types of conveyors and other equipment are available so that your production conditions may be closely simulated. You and your associates are invited to witness these tests and to discuss your specific coating operation with our experienced engineers. Ransburg engineers not only are trained in electrostatics, but have broad, practical back-

grounds in general production operations, methods, plant layout, industrial painting, and its allied operations.

RECOMMENDATIONS: Drawings are prepared to show exactly how the process may be incorporated in your production line and specific recommendations submitted for your approval and decisions.

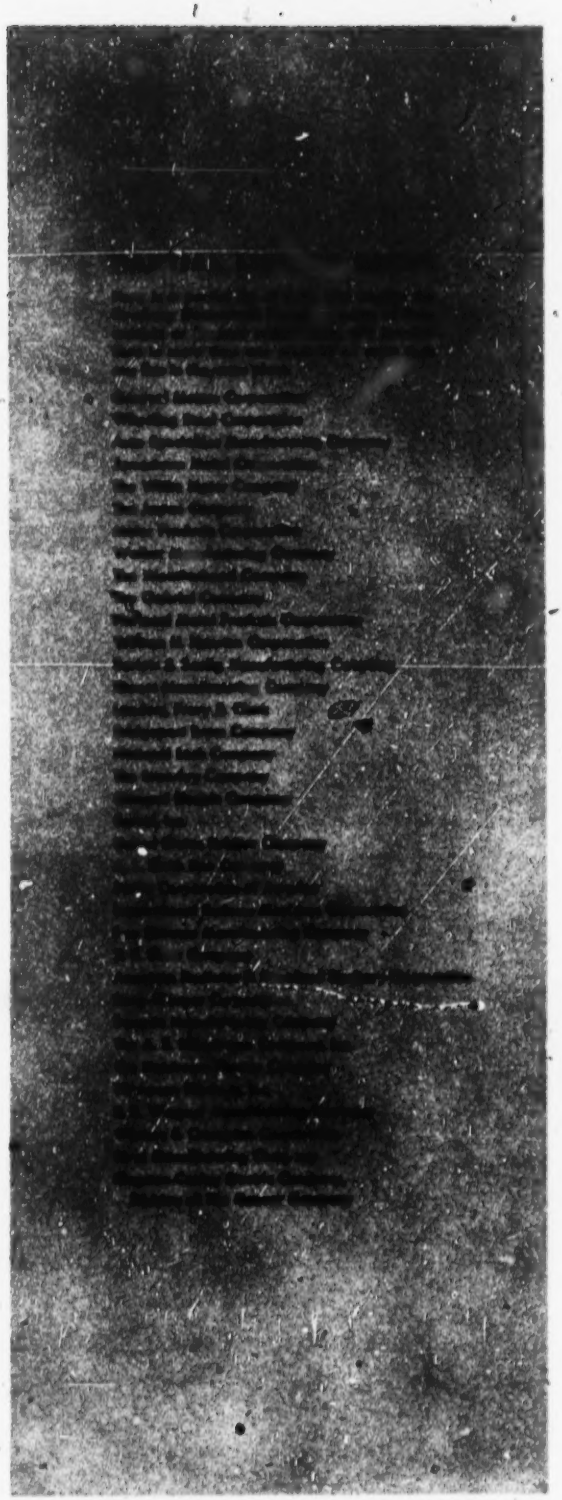
Obviously, all of the above steps are without obligation to you.

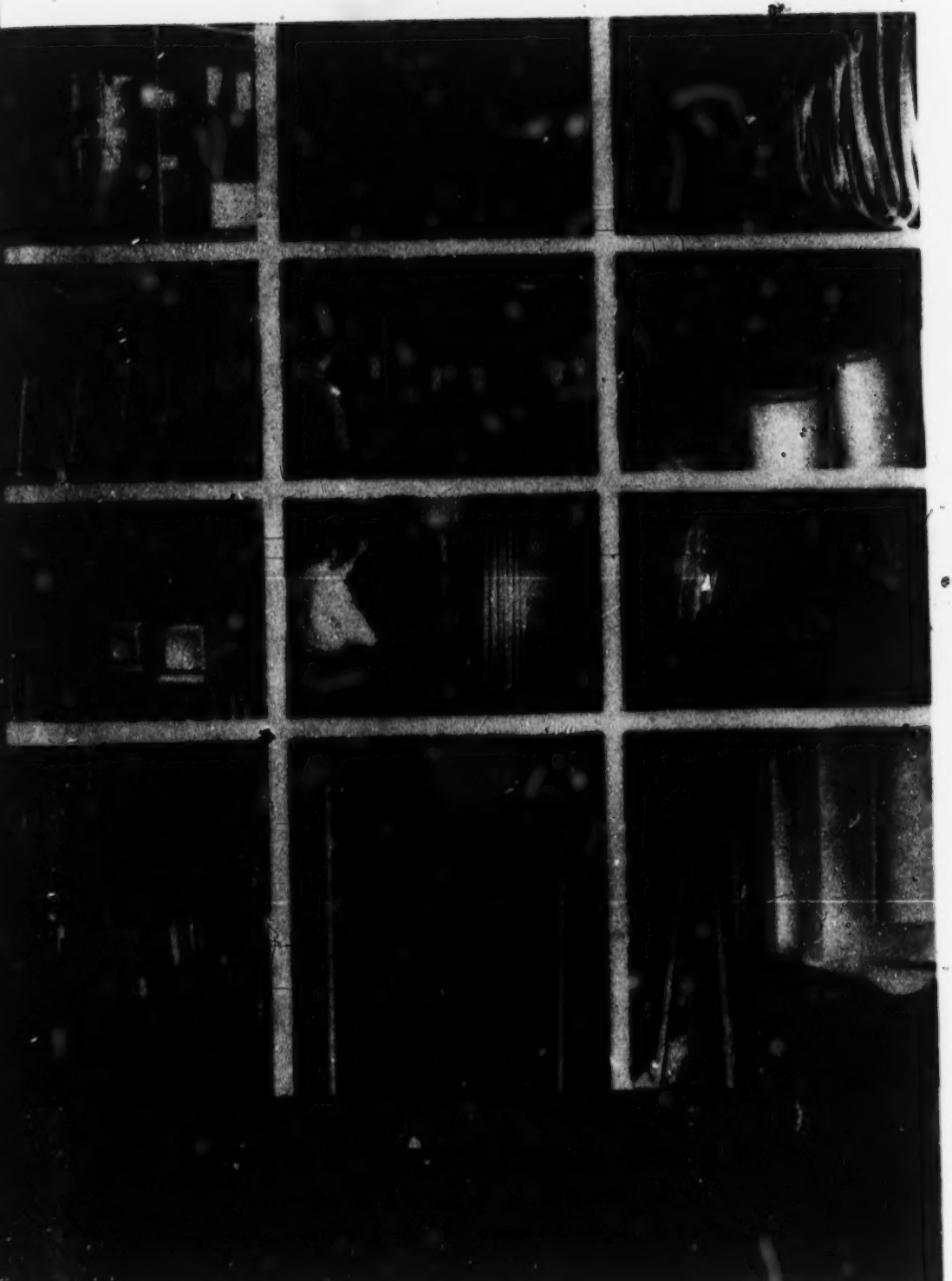
PRE-INSTALLATION ENGINEERING: After your acceptance, the plans are re-checked and explicit instructions, diagrams and detailed installation data are furnished you.

INSTALLATION: Ransburg engineers supervise the installation of our electrostatic equipment . . . and thoroughly train your operator in its use.

SERVICE: Ransburg supplies replacement parts for the electrical equipment and engineers are always available to consult with you on your painting problems.

You can evaluate for yourself the inherent advantages of our processes when you see your products coated in our engineering laboratories.





PLAINTIFF'S EXHIBIT NO. IIII.

Ransburg No. 2 Electrostatic Process.

An Amazing Development in Spray Painting.

The Scope of the No. 2 Process.

Type of Article

This process can be used profitably to coat the exterior surfaces of metallic (magnetic or non-magnetic) items where production volume justifies consideration of conveyorized finishing operation. Many items made of non-metallic materials also can be coated.

Type of Materials

Most coating materials which can be readily atomized can be applied by this method. Enamels, lacquers, and varnishes, whether conducting or non-conducting, are handled satisfactorily. Wrinkles offer no special problem.

Type of Conveyor

Any kind of conveyor—monorail, spindle, cross-bar or belt-type—can be used.

Production Rate

The No. 2 Process is capable of handling any reasonable production rate.

Power Requirements

The system normally operates from a 220 volt, 60 cycle, single phase supply. Where this type of supply is not available, special equipment can be furnished.

Ventilation Requirements

Since there is no paint overspray to be exhausted, a relatively small positive air movement for the removal of solvent vapors is all that is required.

Maintenance

Clean-up maintenance is substantially reduced. Mechanical maintenance is proving to be equally negligible because of the very high quality incorporated into the design of the equipment.

Equipment

Ransburg supplies the complete automatic coating unit, consisting of the source of electrostatic potential, electrical controls, insulators, atomizing heads, and coating material handling system. All that the user need to furnish is the conveyor, workholders, and solvent ventilation means. Drawings of the proposed set-up are included in our Engineering Service.

PLAINTIFF'S EXHIBIT PPPP.

Behr-Manning Corporation, Troy, New York.
Executive Offices.

November 22, 1940.

Mr. Harper J. Ransburg,
Harper J. Ransburg Company,
Indianapolis, Indiana.

Dear Mr. Ransburg:

From several sources, it has come to our attention that your comany has been interested in developing an electrostatic method for depositing paint in a finely divided or suspended particle form on irregularly shaped objects.

For many years, Behr-Manning has been employing the electrostatic method to deposit finely divided material of all types and I am writing to you because of our apparent interest in the same development.

We have been manufacturing sandpaper made by the electrostatic process since 1926 and our development work of course preceded this date. From the propulsion of abrasive particles, we moved into new fields involving the deposition of finely divided or suspended particles and during the past few years, we have successfully developed electrocoated pile fabrics for use as automobile upholstery, dress material, etc. Many of our operations have been covered by patents some of which you probably may have seen and many patent applications are pending. We have been interested in the field in which you apparently are working and have done developmental work, namely, the electrodeposition of paint or other liquids and some of our patent coverage is directed to this art.

It has occurred to use that it would not be amiss to arrange for a meeting either in Indianapolis or Troy at the convenience of both parties to discuss our individual interests and positions in the electrostatic deposition field. We will be glad to have representatives visit you in Indianapolis on a mutually satisfactory date or we will be pleased to see you here if you prefer. Will you kindly let us have your reaction to our proposal.

Yours very truly,

Behr-Manning Corporation,
Elmer C. Schacht,
Vice President.

E. C. Schacht
HAH

Behr-Manning Corporation

Division of Norton Company

Abrasive Paper and Cloth Oilstones Abrasive Specialties

Troy, New York,

March 21, 1941.

Mr. Harper J. Ransburg,
Harper J. Ransburg Company,
Indianapolis, Indiana.

Dear Mr. Ransburg:

Our reply to your letter of March 4 has been delayed because of my absence from Troy while on a short vacation

Since our meeting in Chicago and your visit to Troy, we have become increasingly busy and are setting new production records monthly. Under these circumstances, it is difficult for Dr. Oglesby and myself to get away from Troy at the same time. Because of this condition, it occurred to me that we might save time by having the patent conference at which I do not have to be present at one time and then hold what might be called a business session which I would like to attend at a subsequent date. With this in mind, it further occurred to us that your Indianapolis patent attorney might make occasional visits to Washington where our counsel, Mr. John J. Darby, is located. Dr. Oglesby visits Mr. Darby at regular intervals and he could time his visit to Washington so that he was there when your Indianapolis attorney was also in Washington.

The patent attorneys could spend a day in a conference solely devoted to patent matters and to the appraisal of our respective patent positions. Their recommendations

could be reported back to their respective clients and then you and I could decide as to future meetings for business discussions. There is always a possibility that no meetings would be required.

What is your reaction to this proposal? If it is favorable, please let me know and kindly arrange to give us as much notice as possible in advance of the date when your attorney will be in Washington prepared for the conference described above.

With best wishes,

Yours very truly,
Behr-Manning Corporation,
Elmer C. Schacht,
Vice President.

E. C. Schacht
HAH

Behr-Manning Corporation

Division of Norton Company

Abrasive Paper and Cloth Oilstones Abrasive Specialties
Troy, New York,

May 20, 1941.

Mr. Harper J. Ransburg,
Harper J. Ransburg Company,
Indianapolis, Indiana.

Dear Mr. Ransburg:

We have just received a letter dated May 15 from Mr. W. L. McKnight, President of Minnesota Mining & Mfg. Company which contains the following statement:

"I have a very strong feeling that it is unwise to disclose these pending patent applications, particularly where

there may be a conflict of interests and my natural inclination in this matter is that it would be a mistake to make these disclosures."

This quotation refers, as I have previously explained, particularly to the Smyser reissue application and to one or two other pending electrostatic applications which the Minnesota Company is solely prosecuting but over which Behr-Manning will eventually exercise control due to acquisition by assignment.

The above decision would appear to operate to terminate our negotiations for the time being since you have indicated very naturally that you would not care to make complete disclosures of your pending patent material unless we were both willing and prepared to do likewise. Under the circumstances, we would propose that we hold the entire matter in abeyance and review the situation at the end of a 90-day period. If this arrangement is agreeable to you, you may expect to hear from us again in 90 days. With best wishes.

Yours very truly,
Behr-Manning Corporation.

July 3, 1944

Dictated July 1st.

Mr. E. C. Schacht
Behr-Manning Corporation
Troy, New York

Dear Mr. Schacht:

It has been some time since our friendly discussions were terminated by your letter of May 20, 1941. We are wondering, if within this lapse of time, your conditions might have altered sufficiently to warrant our reopening these discussions.

Our work has progressed considerably and we are now preparing to launch an increasingly aggressive operation in the application of various coating materials to manufactured articles in the industrial finishing field. You may or may not have heard that some of the preliminary installations we have made have proven highly successful and are attracting some worthwhile attention.

I know that you will be interested to learn that our patent position has been improved by the issuance of five patents to us, and the acquisition of the Pugh patent. We have also been fortunate in effecting some very constructive improvements on which we have applied for additional patents.

Notwithstanding the wide separation of the fields in which we have been operating, it is easily possible that certain aspects of our patent protection might well overlap, particularly in view of the present Pugh status.

It seems that we mutually can expect every advantage from resuming the discussion to some mutually satisfactory conclusion so that each of us may aggressively pursue our endeavors without concern. In addition to the practical advantages we see in renewing the discussions, it would be a pleasure to see you again. Your reaction and comments on the above would be appreciated.

Yours very truly,

Harper J. Ransburg Co.

By

HPR:rm

August 8, 1944

Mr. E. C. Schacht
Behr-Manning Corporation
Troy, New York

Dear Mr. Schacht:

In harmony with your request we are enclosing copies of our issued patents, pertinent to our discussions, Nos.—

1,855,869
2,247,963
2,270,341
2,334,648

We would like to point out that the claims in our patent No. 2,334,648 are of considerably greater significance than one not well versed in our particular field could possibly appreciate.

Patent No. 2,270,341 is the one to which we referred as possibly interesting to you in the abrasive or pileous fabric field, or at least one in which you could contribute materially in the composition cork industry or the fireproof insulating single industry.

We have fourteen applications pending on electrostatic processes, some of which we feel will have a greater significance than some of the enclosed, one of which we believe to be a decided improvement over Meston.

We are looking forward to exploring these possibilities with you in the near future.

Yours very truly,
Harper J. Ransburg Co.
By

HJR/IK

(Form of Western Union Telegram.)

Aug 10 AM 2 51

CB48 NL=Leland 9

Harper J Ransburg Co=
Indpls=

Cursory Review Of Smyzer Indicates That Of 59 Claims Only Claim 51 And Possible 16 And 58 Are Pertinent But Of Doubtful Validity As Reissued With About Three Years To Run Stop From Nuisance Angle Suggest Negotiating Exclusive License Limited To Your Field Or At Least Non Exclusive License=

Ralph G Lockwood

Smyzer 59 51 16 58

November 13, 1944

Behr-Manning Corporation
Troy, New York

Attention—Mr. E. C. Schacht

Dear Mr. Schacht:

Had anyone told me we would be so long writing after receipt of your letter of October 30 I would not have believed them. The almost continual absence from the city of one or more of us and a very heavy schedule here has prevented our getting together.

Our greatest concern and that to which we have given the most thought and consideration was the question of just how to word our future license agreements so that there could be no question in the minds of our users that they were restricted from operating in your fields, and still not create undue sales resistance for ourselves. It was

originally our thought that this would best be accomplished by adding to our license agreements "said right does not include the use of this process in the manufacture of abrasive articles or articles coated with particles of fibrous material of every kind."

However in reading this from our customers' viewpoint it is conceivable that "fibrous materials" could possibly be interpreted by one who was not present at our meetings to mean particles of any materials in nature which are fibrous in character. This interpretation could bring into this category practically all organic materials or their derivatives and might even be broadly construed to include cellulose lacquers or paints inasmuch as fibrous materials are used in their manufacture. We are certain it was your feeling that this term should have included only those materials which were used in a filament-like shape regardless of their basic or molecular character. We feel it is more in harmony with the thoughts expressed at our meetings, therefore, to base our description of this particular field on the shape of the particles rather than upon their basic nature. We might point out that fiber-shaped particles would include glass fibers and possibly others which normally would not be considered as "fibrous material."

We, therefore, have in mind adding the following, "said right does not include the use of this process on articles used as an abrasive or articles coated with fiber-shaped particles." If you have any contrary views or suggestions for improvement we shall appreciate receiving them.

In view of the above and fostered by our thoughts along this line it occurred to us that the use of the phrase "particles of fibrous material" throughout our agreement could well be misinterpreted by an outsider. We feel therefore that this might be more clearly restated following the same thought.

Accordingly, we have the following changes to suggest

in your draft of the agreement with the thought that they will clarify it and be more in harmony with our meeting of minds in our recent meetings. Several other minor changes are also suggested.

Page 1—last line of your draft

We have changed the word "paint" to read "liquid coatings" because we feel this more aptly describes our field.

Page 2—line 6:

We have changed the phrase "and fibrous coated articles" to read "fields and in the field wherein articles are coated with fiber-shaped particles."

Paragraph (b):

For the above reasons we changed "particles of fibrous material" to read "fiber-shaped particles of material."

Paragraph (c):

Here "said abrasive particles" had no antecedent and this paragraph might not have been interpreted as specifically relating to paragraph (a) and (b) as was obviously intended. Therefore we eliminated "said" and added "used in connection with the fields described in (a) and (b) above."

Page 3—2nd line from bottom:

Here we have added "orientation, separation, grading, or classification" so as to make the grant to us conform to the grant to you.

Page 4—paragraph 3, line 7:

We have changed "cooperative" to "cooperating."

Page 4—3rd line from bottom:

We have changed "an" to "and."

Page 5—line 7:

We have changed the word "wherein" to read "in the event" feeling the new phrase is less ambiguous and more direct than the original single word.

Believing you will agree that these changes better express our meeting of minds, we are enclosing six executed copies for your approval.

We have also made the following corrections in Exhibit A:

United States Patents:

Pugh—1,855,869 (instead of 1,855,859)

Applications:

3rd one listed:

Ransburg, Miller & Curtis—Apparatus for Spray Coating Articles—Ser. No. 516,778—filed Jan. 3, 1944

7th one listed:

Miller—Method and Apparatus for Electrostically Spray Coating Patterns—Ser. No. 540,627—filed June 16, 1944

8th one listed:

Ransburg & Curtis—Coating Apparatus—Ser. No. 542,503—filed June 28, 1944

9th one listed:

Ransburg & Curtis—Method and Apparatus for Coating Hollow Articles—Ser. No. 542,558—filed June 28, 1944

Another point which arises in our minds is that pertaining to our outstanding license agreements which were referred to when you were here but which are not mentioned in the agreement. While we feel it most improbable that

any of our licensees will or can ever use the process which they are licensed to use, in such a way as to invade, even to the slightest extent, any of the fields in which you are operating, we nevertheless feel that there should be complete understanding in respect to such licensees. Our execution of the agreement is, therefore, necessarily upon the assumption that it is subject to these outstanding licenses. In order that you may have full information on the subject and because we feel also that doing so will reassure you as to the improbability of these licensees ever invading your fields, we enclose a list of such licensees and the description of their rights to use the process under their respective agreements. We also have a few proposals outstanding which, if accepted, will fall into the same category.

Our patent applications are being reproduced and will be fowarded to you upon completion.

We, too, are looking forward to a pleasant and harmonious relationship with you through the years. In fact, we enthusiastically feel that we will be of much benefit to each other.

Yours very truly,
Harper J. Ransburg Co.
By .....

HJR/IK

Harper J. Ransburg Co.
Electric Coating Division
1234 Barth Avenue
Indianapolis 1, Indiana

November 13, 1944

Existing Ransburg Spray Coating License Agreements

Butler Manufacturing Co., Galesburg, Ill.

With twelve (12) stationary spray guns for coating metal corrugated roof and wall sheets as per our drawing #130349.

Cheney-Bigelow Wire Works, Springfield, Mass.

Electrostatically spray coating rocket launchers 2.36 M9A1 as per our drawing #130276.

Ferro Enamel Corp., Cleveland, Ohio

To conduct and carry out experiments with the above described equipment in spray coating liquid porcelain enamel.

Florence Stove Co., Gardner, Mass.

For the purpose of spray coating 10½" shell case containers on one monorail conveyor as shown on our drawing #130251.

The Japan Company, Cleveland, Ohio

With four (4) stationary spray guns and two electrode systems, and to be used as specified by First Party for spraying mines and other war items.

Jamestown Steel Partitions Co., Jamestown, New York

For electrostatically detearing dipped fins and electrostatically spray coating the body of 100-Lb. Navy practice bombs on one monorail conveyor as shown on our drawing #130302.

Keeler Brass Company, Grand Rapids, Mich.

To electrostatically spray hardware using two (2) stationary guns in the manner shown on our drawing #130303.

Kingston-Conley Electric Co., No. Plainfield, N. J.

Electrostatically spray coating motor parts and castings on a two-gun setup with one conveyor as per our print #130341.

Landers, Frary & Clark, New Britain, Conn.

For spray coating automobile window mouldings with one (1) stationary spray gun as per our drawing #130282 and experimentally spray coating or dipping and detearing post war production items.

Motor Products Corp., Detroit, Mich.

For spray coating automobile window moundings with a five (5) spray gun unit on one monorail conveyor as shown on our drawing #130271.

Nineteen Hundred Corp., St. Joseph, Mich.

The spray coating of pump and gear case parts for a two (2) spray gun operation as shown on our drawings #130277 and #130278.

Noblit-Sparks Industries, Inc., Columbus, Indiana

For spraying 100-Lb. bombs with four (4) stationary spray guns.

Norris Stamping & Mfg. Co., Los Angeles, Calif.

With the above listed equipment for one paint spray unit as per our drawing #130159 for painting 3" 38 aluminum containers or any other metal products manufactured by Second Party.

Pemco Corporation, Baltimore, Maryland

For test purposes to experiment with and develop the most suitable porcelain enamel compositions for use in these processes.

Rheem Manufacturing Co., Chicago, Ill.
For spraying 100-Lb. bombs with six (6) stationary spray guns as shown in our drawing #130158.

Wheeling Steel Corp., Wheeling, West Va.
For spraying 3 to 6-gallon containers with eight (8) stationary spray guns.

Harper J. Ransburg Co.
Indianapolis

Behr-Manning

November 24, 1944

Mr. Harper J. Ransburg
Harper J. Ransburg Company
Indianapolis, 7, Indiana

Dear Mr. Ransburg:

Enclosed you will find three copies of the electrocoating agreement which have been signed by Behr-Manning in the form in which the agreement was redrafted as outlined in your letter of November 13. We think that the suggested changes were in accord with our verbal discussion and reflect a true meeting of minds.

It is my impression that the copy of the electrocoating agreement which you have executed with your existing licensees or had under negotiations with prospective licensees at the time our agreement was being consummated, contains an indication of the purpose for which the licensed Ransburg equipment is to be employed by the licensee.

If this is the case and since no licenses have to your knowledge been granted in the flock or abrasive fields, we do not foresee difficulty or conflict with any of your existing licensees and it should not be difficult for you to so

limit your future licensees as to prohibit the employment of the patents under which you have given us exclusive rights for abrasives and flock coated articles, in these fields.

We are looking forward to a pleasant and mutually profitable association in this new cross license agreement.

Yours very sincerely,

Behr-Manning Corporation,
E. C. Schacht,
Vice President.

PLAINTIFF'S EXHIBIT NO. TTTT.

A. P. Parts Corporation
1801 Speilbusch Avenue
Toledo, Ohio

April 6, 1955

Attention: Mr. N. J. Osborn

Dear Mr. Osborn:

Subsequent to my last letter to you we have had an opportunity to check the atomization characteristics of the rust inhibiting material which you left with us during your recent visit to the laboratory. Actually, this material handles very poorly with our equipment because of the fact that the solvents in it are so very fast and therefore leave the material almost instantaneously with the break-up of the liquid into the spray. Because of this fact, we do not feel free to recommend our processes to you.

Actually, the nature of this material is such that it is highly inflammable and highly toxic and consequently we do not believe that it could be handled with a spray method without very special precautions.

We do not know what you had specifically in mind for this particular material but trust you will feel free to contact us further if we can help you in this connection.

Very truly yours,

EPM:ab
CC: Darrel E. Creps

Emery P. Miller

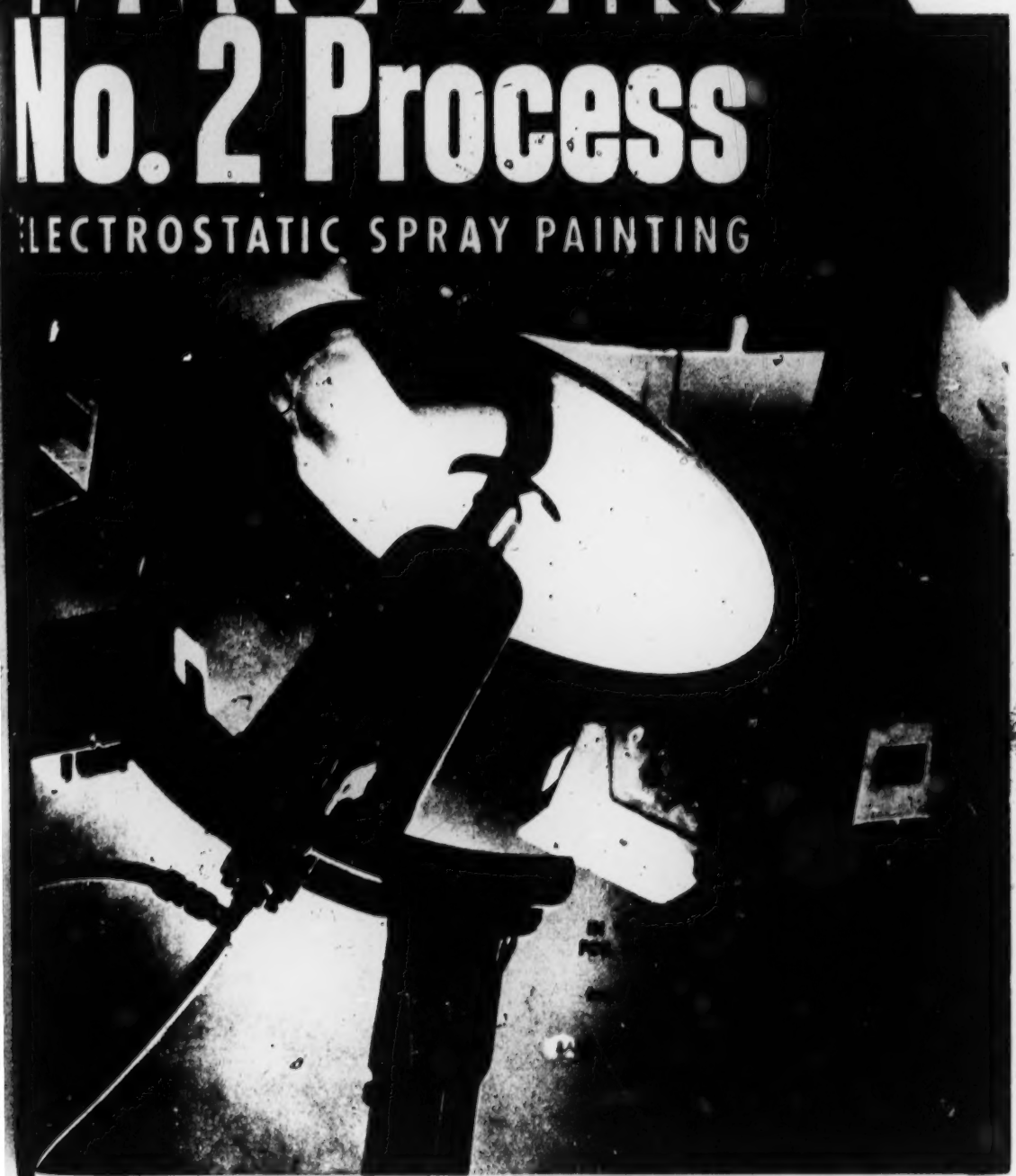
PLAINTIFF'S EXHIBIT UUUU.

877

RANSBURG

No. 2 Process

ELECTROSTATIC SPRAY PAINTING



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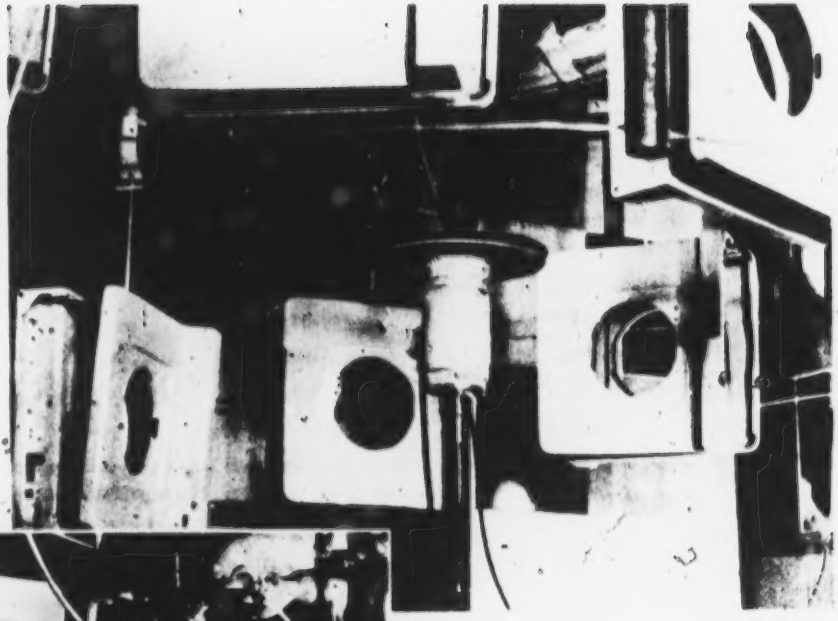
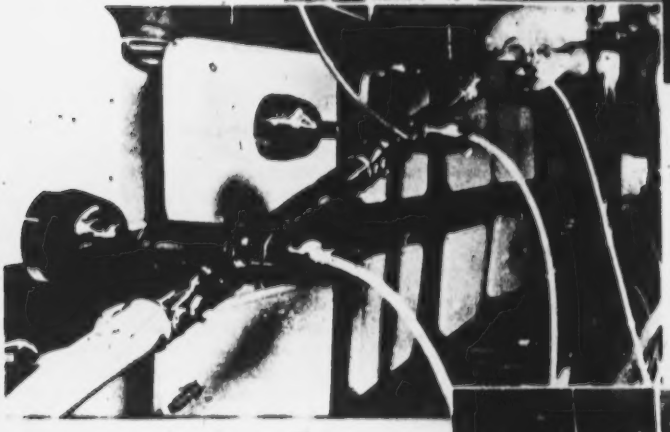
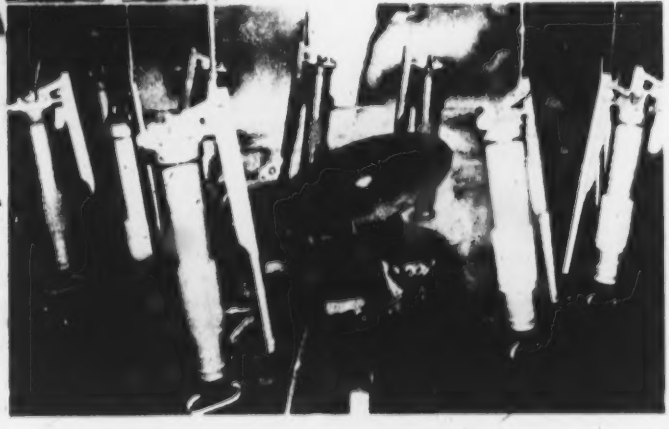


GENERAL ELECTRIC was the first to use Ransburg No. 2 Process for the application of porcelain enamel. GE washer and dryer parts are successfully coated electrostatically on these home laundry production lines at Appliance Park, Louisville. Approximately three times as many parts per gallon of slip are coated electrostatically as would be coated by ordinary air spray. About 97% of the atomized enamel is deposited on the ware. Only one electrostatic operator and three touch-up men are required to process almost a million square feet of cover coat a month.



With the Ransburg No. 2 Process, HAMILTON MANUFACTURING CORPORATION, Columbus, Indiana, gets double the paint mileage over hand spray on COSCO metal household furniture. Seven different colors are used, and depending upon daily production demands, 10 to 15 color changes are made daily.



Automatic electrostatic spray stepped up paint mileage 150% over hand spray at LINCOLN ENGINEERING CO., St. Louis, when Ransburg No. 2 Process atomizing disk replaced hand spray in the painting of lubrication lever guns. Where they used to get 100 units per gallon of paint, they now get 250.

o prove the painting of YOUR products with

RANSBURG

Electrostatic Painting Processes

Let us make laboratory tests and prove the advantages and cost-saving benefits of painting YOUR products AUTOMATICALLY with one of the Ransburg Electro-Spray Processes.

GET THE FACTS — IT COSTS YOU NOTHING!

● **First,** Ransburg sales engineers make a survey in your plant to check the possibilities of using Electrostatic Spray Painting on your products. Next, you send samples of your unpainted products—with paint—to the Ransburg laboratories in Indianapolis.

Here, the technical staff takes over. The Ransburg Engineering staff—which includes Ph.D's and Masters in Physics, Science, Electrical, Mechanical and Chemical Engineering—makes a complete study of your job. They also have the "know how" gained from two decades of research in electrostatic painting and years of actual experience in the field. Ransburg, you know, was the pioneer in Electrostatic Spray Painting. Our engineers and technicians have at their disposal every facility for conducting complete tests, simulating your own production conditions. There's a conveyorized lab set-up—22 in all—to handle products ranging in size from automobile bodies and chassis to smallest parts. They'll design workholders, if necessary, and determine exactly how your job can be run to your best advantage.

After preliminary studies and tests, you are invited to Indianapolis to see your job run in the lab. If you wish, photos and even movies of your test run can be made and furnished for your own production people to study. You see first-hand what Ransburg Electrostatic Spray Painting can do for you.

YOU GET PAINT AND LABOR SAVINGS

Paint coverage is accurately measured during the demonstration. The Ransburg No. 2 Process will provide savings up to five times the paint mileage of hand spray. And, one unit can do the work of many hand sprayers. You will see the improved, uniform quality of the work. . . you'll know what kind of increased production to expect, and you can recognize labor savings. ALL OF THIS WITHOUT OBLIGATION.

Ransburg service doesn't end there. After the equipment is installed in your plant—with our supervisory help—we will train your operators, and continue to work with your finishing department. Our technically-trained field service engineers are always available to assist with any of your finishing problems.

Briefly, that's our story. Now it's your move. Call or write.

STEP BY STEP — HERE'S WHAT YOU GET . . .

- Survey of your plant by Ransburg's experienced field engineers, including savings estimate.
- Lab painting demonstration of your products, using equipment closely simulating your own production conditions.
- Accurate measurements of paint film thickness.
- Engineering report of detailed tests to determine paint and labor savings.
- Coated samples of your job, lab production photos, and even movies if desired.
- Detailed drawings of equipment and workholder.

All of the above without obligation to you. And, before equipment is installed you receive detailed, pre-installation instructions. Too, a well-qualified, experienced engineer supervises installation and trains your operator on the job. Ransburg offers continuing laboratory and field service to help you with any of your finishing operations.

880

Scope of the NO. 2 PROCESS

TYPE OF ARTICLE

Almost any metal article, and many non-metallic articles, can be coated by the No. 2 Process. Although ideally suited for coverage of exterior surfaces, this process can coat many recessed areas.

TYPE OF COATING

Most coating materials can be applied. Lacquers, varnishes, and synthetic enamels, whether electrically-conducting or not, can be handled satisfactorily. "Special" formulations are seldom needed.

PRODUCTION RATE

Any reasonable production rate can be met by the No. 2 Process. Conveyorized handling of the work is a prerequisite.

TYPE OF CONVEYOR

Monorail, spindle, cross-bar or belt conveyors can be used.

POWER REQUIRED

Average power required is 2 kw, from a 220 or 440 volt, 60 cycle supply.

VENTILATION REQUIRED

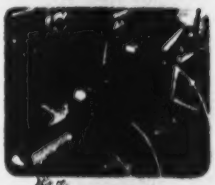
Only a relatively small air movement for removal of solvent vapor is required. Conventional type spray booths are not necessary since there is no overspray paint to be exhausted.

MAINTENANCE

Clean-up and maintenance care is substantially less than other spray methods.

EQUIPMENT

When desired, Ransburg will supply the complete automatic coating unit, consisting of electrostatic voltage source, electrical controls, insulators, atomizers, and coating material supply system. The user furnishes only the conveyor, workholders and solvent ventilation.



"THE BIG ATTRACTION"

Available upon request—16mm. sound-color, 30 minute film. In story form, explains how No. 2 Process works. Shows production line operation on a wide variety of products. *Write*

RANSBURG ELECTRO-COATING CORP.
Indianapolis 7, Indiana.

PLAINTIFF'S EXHIBIT NO. VVVV.

Formerly at

Now at
P. O. Box 116
Bay Village, Ohio
Phone (Cleveland)
TRinity 1-0062

August 14, 1951

The Cleveland Welding Company
West 117th and Berea Rd.
Cleveland 11, Ohio

Attention: Mr. James Miller

Gentlemen:

Enclosed is a Ransburg Electro-Coating Corp. Brochure which depicts the theory and operating data on five initial installations of an amazing new process for automatic electrostatic spray painting.

This process designated as "No. 2," in contrast to the well known Ransburg Electrostatic spray using conventional spray guns, employs a special type of coating equipment which is furnished completely by the Ransburg Corp. All that the user needs to supply is the conveyor, workholders and ventilating means.

The efficiency of the new development—in many instances exceeds 99%. There is no overspray to be exhausted. The ventilating means is to carry away the thinner vapors.

Complete laboratory facilities at Indianapolis are available, at no obligation to you, to run simulated production on your parts using your own paints or coating materials. Any item whose production volume justifies consideration of a conveyorized operation may be an application.

Simply write or phone for an appointment that suits your convenience.

Very truly yours,
Darrel E. Creps
A Distributor for
Ransburg Electro-Coating Corp.

DEC/s
Encl.—Ransburg No. 2 Brochure

PLAINTIFF'S EXHIBIT WWWW.

July 9, 1951

Aluminum Goods Manufacturing Company
Manitowoc, Wisconsin

Attention: Mr. C. O. McGlynn.

Gentlemen:

It was a pleasure to visit your plant last Thursday, and your courtesy and cooperation in arranging a round-table discussion concerning your painting problems was highly appreciated.

In harmony with our conversation, to aid you in understanding our new electrostatic method I refer you to the drawing I left with you, No. 230202. We have taken the liberty of indicating some of the features of this equipment on the accompanying drawing in red pencil so that we can refer to it in our discussion. In coating these objects, the drawing shows them as being supported from an overhead monorail conveyor which is the best way to run your particular product. However, this is not an essential feature of our method. The object can be supported in any way which is convenient to the remainder of the operation.

This process is primarily a completely automatic, electrostatic operation. Coating material is broken up and precipitated onto the article entirely by the action of electrostatic forces so that no air is involved in the application. Because of the complete absence of air and of the definite attraction of the coating material to the object, the efficiency of this process is quite high. On an object such as we visualize your cartridge tank to be, the efficiency could easily be 95 to 99%. With such efficiency you can readily appreciate the advantages which such a process has over the normal spraying operations. In operation, the cartridge container would be hung from an overhead conveyor or otherwise suitably supported on a hook which is arranged to rotate the object as it is carried past a particular position along the conveyor. At this position along the conveyor, and to one side and spaced from the objects will be placed our new electrostatic atomizers. For your object, we believe that six of our atomizers, as shown on our drawing, will be sufficient.

Coating material from a container is pumped to the atomizing heads by a positive displacement pump which is variable in its speed so that the delivery to the heads is readily adjustable. When this material arrives at the heads it is distributed over the inside surface of the head by virtue of the head being rotated about its own axis. This rotation results in a very thin, uniform film of paint at the front edge of the head. The heads are charged to a high voltage by a voltage peak, the other end of which is grounded as are the articles on the conveyor. The electrostatic field which exists between the heads and the objects as a result of this charging causes the coating material to break up into a fine spray and to move across the intervening space to the objects which collect it as a uniform coating.

Your production of 130,000 cans per month could easily

be handled with our equipment, parts being hung on 9" centers with a speed of 4.5' per minute. Our equipment is not limited by conveyor speed. For example, we have many installations where the conveyor speed is running at a high rate which, of course, is necessary to their production requirements. Therefore, it is readily understandable that the conveyor speed to meet your production needs is quite nominal and would not present any problem in conjunction with our equipment.

We believe that with this explanation and through reference to our drawing, you will have a general understanding of just how our new process operates. It is so efficient that a spray booth in the usual sense of the word is not necessary. A hood should be placed about the equipment, however, to exhaust such vapor fumes as result from the atomization of the coating material. In your particular case the spray booth which you now have could be utilized and a hood would not be necessary.

We supply this equipment and license the use of this new process to you under an initial fee and a monthly license fee. For more specific detail we refer you to our license agreement that was presented to you by the writer. For this initial fee we supply to you the atomizing heads and their supports, the coating material, the pumps and the fluid hoses connecting the atomizing heads with the pumps. We further furnish the high voltage supply, the high voltage conductor for connecting the supply to the atomizer, and the electro-controls for controlling this high voltage equipment. In other words, you would only need to supply the conveyor handling mechanism, the exhaust hood, and the electrical service to which our equipment will be attached.

As discussed with you, the monthly license fee would be based upon the amount of coating material used with our equipment and would be 20% of the cost of the material

used in any particular month; it being understood that there would be a minimum charge of $100.00 per month regardless of usage of the equipment. We always are certain that the use of our equipment much more than compensates our users for the fees which they pay us so that you are certainly able to expect considerable savings over normal processes through its use.

We are prepared here in Indianapolis to demonstrate this process to you and would be most happy to have this opportunity. If it would be possible, we would like to demonstrate it to you on your own cartridge tank or a similar item so that you can actually know before hand the type of finish that you would obtain and understand approximately what mileage efficiency could be obtained with this method. We invite you to consider coming to Indianapolis for this purpose and would be most happy to make any arrangements with you for this end.

Thank you again for the courtesy and hospitality that was extended to me. It was a pleasure to have visited your plant and present this material to you and we are looking forward to a pleasant business relationship. If there are any questions concerning this matter, please do not hesitate to contact the writer at your earliest convenience.

Very truly yours,

Ransburg Electro-Coating Corp.

John E. Maxwell.

JEM:db

P.S. Within the next two or three days we will have completed drawings for your specific job which will show the exact dimensions required for the installation of our equipment in your plant.

PLAINTIFF'S EXHIBIT XXXX

January 18, 1954

Aveo Manufacturing Corp.
Appliance and Electronics Division
1329 Arlington Street
Cincinnati, Ohio

Attention: Mr. A. D. Redfield.

Gentlemen:

Pursuant to the discussion between your Messrs. A. D. Redfield and W. Kunz and our Mr. H. E. Downer, enclosed please find four copies of our Electro-Spray Agreement No. 5228. It is understood that this letter is a part of Agreement No. 5228 and amends the agreement as follows:

1. The first "Whereas" clause is rewritten as follows:

"Whereas, Ransburg (a) is the Owner of the United States Letters patent and patent applications set forth in attached Exhibit A, and has the right to grant licenses under the United States Letters patent and patent applications set forth in attached Exhibit B, pertaining to and covering methods and apparatus used in electro-statically depositing liquid spray particles formed by airless atomization (without the use of compressed air), the Process so used being hereinafter referred to as 'said Process' and (b) has acquired much engineering data and experience pertaining to said Process, is conducting research in the field, has performed a substantial amount of engineering in adapting said Process to commercial use, has supplied User with the result of said engineering pertinent to User's products, and has designed special equipment therefor; and"

2. The following sub-paragraph is added to Paragraph 1:-

"It is understood that the unit illustrated in Drawing No. 230803-B is intended specifically for use in coating Washer and Dryer Cabinets, Tops and Doors, and should any changes be required in said unit or ~~should any additional equipment be required for~~ adapting it to coat other articles, Ransburg shall not be under any obligation to supervise such changes or furnish such additional equipment unless both User and Ransburg mutually agree with regard to the allocation of costs for such changes or such additional equipment. It is also understood that the monthly fees specified in Paragraph 10 shall be adjusted in accordance with Ransburg's standard schedule for any changes in the unit or for articles other than Washer and Dryer Cabinets, Tops and Doors."

3. Line 3 of Paragraph 2 is amended as follows:

Change "upon" to—within 30 days after—

4. Line 6 of Paragraph 9 is amended as follows:

Change "six" to—twelve—

5. The second sub-paragraph of Paragraph 9 is rewritten as follows:

"In the event User shall fail to perform any of the conditions or obligations of this agreement, Ransburg may (without prejudice to its rights to recover any amounts owing by User as herein provided, or any damages for breach of this agreement) terminate this agreement, upon giving to User 30 days written notice, and take possession of its equipment without notice and without being liable to any suit, action, indictment, or other proceedings by User or any one claiming under it; however, if User corrects the breach within said 30 days, then this agreement shall continue as though no default had taken place. Any delay, concession or indulgence on the part of Ransburg in enforcing any of its rights in any default shall not be deemed a waiver of such rights."

6. The following sentence is added to the end of the third sub-paragraph of Paragraph 10:

> "Under this sub-paragraph relating to taxes, licenses or fees imposed by any governmental authority, User shall for no calendar year be required to pay or to reimburse Ransburg in an amount in excess of 3% of the replacement value of the equipment furnished under this agreement."

7. The following is added at the end of the second sub-paragraph of Paragraph 12:

> "This agreement shall also inure to the benefit of wholly-owned subsidiaries and successors of User, without, however, relieving User of any of its obligations hereunder, but shall not inure to the benefit of the assigns or legal representatives of User without written consent of Ransburg, which consent shall not, however, be unreasonably withheld."

With regard to Paragraph 3 entitled "Supervision," by this paragraph we undertake to furnish supervision necessary for placing our equipment in readiness for operation in your plant without any additional charges beyond the fees specified in Paragraph 10; however, as explained in the above mentioned discussion, should our supervisor be required to make more than one trip to your plant or be delayed at your plant for any cause not chargeable to us, then we would charge you $75.00 a day and any necessary transportation expenses as result of such additional trip or trips, or such delays. For example, if you would request our supervisor to be present at your plant on February 1st and upon his arrival he would be informed by you that due to delay in the installation of your conveyor you are not ready to have our equipment installed, and you would ask him to return two weeks later, we would require that you pay us $75.00 a day for the time of our supervisor in making the first trip and his transportation expenses in making such trip.

With regard to Paragraph 5, Mr. Redfield pointed out that this paragraph excludes any warranty on our part. Such a warranty would not be feasible in an operation such as this when the operation of the equipment is entirely within the control of the customer. We believe that you have fully convinced yourselves that the equipment and the process can perform satisfactorily, or you would not otherwise contemplate entering into this agreement. Where the equipment is to be operated by the customer, the licensor could not guarantee performance. The experience of many customers who are using our equipment constitutes a much better earnest of performance than any written warranty or guaranty could afford.

As explained to Mr. Redfield, the fees specified in our agreements have been arrived at after careful consideration, and they are the standard fees charged all of our customers for this type of unit. In order to adhere to our policy of treating all of our customers on as nearly an equal basis as possible, we cannot change these fees at the request of any one of our customers.

In respect to waiving our monthly fees during such periods as you might be out of production, it would be impossible for us to agree with all of our customers that during the period in which the equipment and process are not in use no monthly fee would be payable. The possibility that there may be periods of time when the equipment is not in use is taken into consideration in arriving at the minimum monthly fee and it is made smaller by consequence of such consideration. If we were to undertake to make exception for the period of time during which our process and equipment are not used by charging proportionately more during periods of use, both the customer and we would come out about the same, but it would require much more bookkeeping and a much more intricate agreement. We believe that you will, upon reflection, agree with us in this matter.

With regard to the future inventions paragraph, we have established a policy of not deviating from this paragraph since it would be unfair to our many customers who have already signed agreements with such provision. Since our company developed the basic method and apparatus which is licensed under this agreement, we feel that it is equitable and fair to ask our customers to give us a non-exclusive license under any improvements which they may make while they are using our basic method and apparatus. By this paragraph, both our customers and ourselves may be protected in using most of the future improvements that will be made on this method and apparatus, since all of our customers of the No. 2 Process have signed an agreement that incorporates a future inventions paragraph.

We trust that the above amendments and explanations will satisfy you and that you will feel that you can now recommend signing the agreement. Upon signing all four copies of the enclosed agreement and this letter and returning all copies of the agreement to us, we will be able to sign the agreement and return two signed copies to you, after which, we will be able to go forward with plans for your electrostatic unit.

Very truly yours,
Harold Ransburg
Harold P. Ransburg, *V. P.*

HPR/HED/be
Encs.

Agreed to this 2nd day of February, 1954.

Avco Manufacturing Corporation
By N. Shaun

This letter was signed by me on behalf of Ransburg Electro-Coating Corp. as Vice President of said Corporation and pursuant to authority vested in me by said Corporation.

Harold Randsburg
Harold P. Randsburg,
V. P.

Exhibit A.

Patent Number	Patent Number	Patent Application Serial Number
2,247,963	2,559,225	626,631
2,270,341	2,567,781	689,116
2,334,648	2,568,611	
2,335,790	2,632,716	
2,417,798	2,636,471	In addition to the above listed applications a substantial number of additional applications are pending. Since there is nothing of public record with respect to many of these applications, we would prefer to furnish a list, or further information with respect thereto, only if you are agreeable to receiving it on a confidential basis.
2,421,787	2,650,329	
2,425,652	2,651,287	
2,428,991	2,655,128	
2,442,986	2,658,009	
2,446,953	2,658,472	
2,463,422	2,662,833	
2,465,128		
2,466,906		
2,486,877		
2,509,276		
2,509,277		
2,509,448		
2,526,763		
2,526,780		
2,531,542		
2,544,806		
2,546,791		
2,550,657		
2,551,035		
2,553,724		

Exhibit B.

Patent Number
2,097,233
2,221,338

Patent Application Serial Number
541,579
662,319
452,632

PLAINTIFF'S EXHIBIT NO. YYYY.

G. A. Chutter
15 Exchange Place
Jersey City 2, N. J.
DElaware 2-1740

Call Report March 11th 1949

General Electric Company
Schenectady, N. Y.

Messrs. Emery Miller, Ed. Radsburg and G. A. Chutter called at the General Electric Company plant at Schenectady on March 9th to talk to Mr. H. L. Erlicher, Vice President in charge of purchasing and Mr. R. R. Rausch, Vice President in charge of manufacturing.

Prepared outline of normal contract in force 3/9/49, and the proposed electrostatic spray blanket agreement for large companies was left in triplicate with Mr. Erlicher and Mr. Sredenschek.

Mr. Erlicher suggested showing the moving picture first and arrangements were made for the projector room in Building 37 for 1.30 P. M. Mr. Erlicher arranged for the following to be present beside himself and his assistant Mr. Sredenschek

Mr. R. R. Rausch, Vice President in charge of Mfg.
Mr. A. T. Chandonnet
Mr. Beardslee
Mr. Charles Whiting, Methods
Mr. A. B. Wellborn
Mr. H. Gordon
Mr. G. E. Collins
Mr. R. Carter
Mr. W. H. Fortington, Methods
Mr. P. W. Sayles

and others whose names did not get listed by the writer. Messrs. Beardslee, Whiting and Fortington seemed very enthusiastic, grasping the significance of the savings to be enjoyed.

The full moving picture was shown after opening remarks by Emery Miller. During the Servel and Studebaker silent pictures, Emery Miller supplied dialogue. After the pictures, Mr. Erlicher suggested a conference in Mr. Sredenschek's office where our proposal was reviewed in detail. Ed. Ransburg went into considerable detail as to the justification of our proposed blanket license, and the reasonableness of the same. Stress was placed on the contribution that Ransburg Electro Coating drive and determination had produced a system that gave industry to day a new, valuable, unique tool capable of savings in excess of $1,000,000 per year to the General Electric Company. The cost of the system to the General Electric Company would be very small, say $50,000 plus alteration costs, or about 5%. Emphasis was placed on the fact that even if the patents were worthless, that we could get the system into profitable operation enough quicker than any other way of handling, that this differential speed was worth the price we were charging, i.e., at $1,000,000 saving per year, 3 month delay would be worth $250,000.

The conference broke up at 4.30 P. M. with the suggestion that they would have to figure what savings could be enjoyed to check our statements. Mr. Beardslee was asked to work out this detail. Mr. Rich of the Patent Department was asked to sit in on this meeting. He seemed to value the spray painting patents lightly, but considered detearing patents good.

I will follow with Schenectady and Eastern plants to keep this boiling. In the meantime, please keep General Electric parts moving as they reach the laboratory.

Erlicher says he saw at Erie, the coating of refrigerator cabinets by "electrostatic or some other process which did not put paint on the floor or walls of the spray booth." Sredenschek suggested that might make an offer but our price looks high. As of to-night, G. A. Chutter suggests standing pat on our price and proposition.

G. A. Chutter

CC: Ransburg Electro-Coating Corp.

PLAINTIFF'S EXHIBIT ZZZZ-1.

Binks Manufacturing Company
3114-40 W. Carroll Avenue, Chicago 12
Van Buren 6-4200

Branch Offices in all Principal Cities

July 3, 1956

Ransburg Electro-Coating Corporation
Barth & Sanders Streets
Indianapolis 7, Indiana

Attention: Mr. Harold P. Ransburg
Vice President

Gentlemen:

We have fully developed and are ready to market a paint sprayer which electrostatically atomizes the paint without making use of air. Since we understand from the trade you have a standard form of patent license, we would appreciate your sending us a copy if your licensed patent is applicable to such a sprayer.

Awaiting your reply, we are

Very truly yours,

John W. Baur,
Chief Engineer, Std. Equipment.

PLAINTIFF'S EXHIBIT *ZZZZ-2.*

Exhibit "B."

Ransburg Electro-Coating Corp.
Ransburg.

Telephone: MElrose 2-7513 Barth and Sanders Streets
Cable address: Ranscoat Indianapolis 7, Indiana

July 12, 1956

Binks Manufacturing Company
3114-40 W. Carroll Avenue
Chicago 12, Illinois

Attention: Mr. John W. Baur,
Chief Engineer, Std. Equipment

Gentlemen:

This is in reply to your letter of July 3 advising that you have developed an electrostatic paint sprayer.

Enclosed are our standard license forms for painting with the type of equipment you mention. We would appreciate an opportunity to get together with you and discuss any questions you may have.

I am leaving the city today, but plan to contact you during the early part of August after my return.

Yours very truly,
Ransburg Electro-Coating Corp.
E. M. Ransburg,

EMR/eh
Encls.

PLAINTIFF'S EXHIBIT ZZZZ-3.

Exhibit "C."

Ransburg.

Electro-Spray Agreement.

No.....

User:

Plant: Units: Drawing No.

Items:

Ransburg-Electro-Coating Corp., of Indianapolis, Indiana (herein called Ransburg), which owns patents and inventions for electrostatically depositing airlessly atomized (without compressed air) liquid spray particles, herein called "the Process," and has done and is doing extensive engineering and research on the Process; and the above User, which desires to use the Process and engineering, agree that:

1. License

During the term and subject to the provisions hereof, Ransburg grants User a non-exclusive license to use the Process at User's plant, with the number of units, in accordance with the drawing made a part hereof (subject to such changes in procedure and specifications as Ransburg may from time to time designate) for coating the items, all as set forth above.

2. Use and Supervision

User will use the Process in accordance with Ransburg's safety and operating recommendations, and will not make any use thereof except as herein provided. Ransburg's duly authorized representatives

shall have the right to enter User's premises during business hours to determine the manner in and extent to which User is using the Process and, to the extent Ransburg deems it desirable, Ransburg may make engineering and or operating recommendations.

3. Fees

User will pay Ransburg at Indianapolis, Indiana: (1) An initial fee of $ within 30 days after the acceptance of this agreement by Ransburg; and (2) For each calendar month during the term hereof a monthly fee (pro-rated for any partial initial calendar month) equal to .

At the request of either party the minimum monthly fee from time to time shall be adjusted commensurate with changes of not less than ten points from the value for January, 1956 of the Consumer Price Index, Large Cities Combined, All Items, of the Bureau of Labor Statistics of the U. S. Department of Labor, on the 1947-1949 base, or any successor thereto.

User will keep and make available for Ransburg's inspection during business hours permanent records of all information required for computing monthly fees. Within 10 days following each calendar month User will furnish to Ransburg a written report containing all information for computing the fee for that month, with User's computation and payment of the fee.

4. Liability

Ransburg shall not be liable to User for damages resulting from the installation, servicing or use of the Process. User indemnifies Ransburg against all claims of others for any damages resulting from the installation, servicing or use of the Process. Ransburg makes no warranty, express or implied, relative to the Process.

5. Term

This agreement shall be in effect from the date of acceptance by Ransburg until terminated as follows: (1) User may terminate as of the end of any calendar month, upon 30 days' written notice to Ransburg; (2) Ransburg may terminate as of any date after three years from the acceptance date hereof, upon six months' written notice to User; or (3) Ransburg may terminate forthwith should User become insolvent or bankrupt or should any breach or default by User remain uncured for 20 days after written notice thereof from Ransburg.

This written agreement constitutes the entire agreement between the parties, and no terms or understandings not herein contained (whether included in any purchase order or otherwise) shall be valid or binding unless contained in a writing signed by both parties. This agreement shall be governed by the law of Indiana.

Signed by User on ..... , 195 .....

Accepted by Ransburg on ..... , 195 .....

(User) Ransburg Electro-Coating Corp.

By ..... By .....

(Title) (Title)

PLAINTIFF'S EXHIBIT *ZZZZ-5.*

Exhibit "D."

Ransburg Electro-Spray Agreement

No.

User:
Plant: Units Drawing No.
Items:

Ransburg Electro-Coating Corp., of Indianapolis, Indiana (herein called Ransburg), which owns patents and inventions for electrostatically depositing airlessly atomized (without compressed air) liquid spray particles herein called "the Process," has done and is doing extensive engineering and research on the Process, and has designed special equipment therefor; and the above User, which desires to use the Process, engineering and equipment, agree that:

1. License

During the term and subject to the provisions hereof, Ransburg grants User a non-exclusive license to use the Process at User's plant, with the number of units, in accordance with Ransburg's drawing made a part hereof (subject to such changes in equipment, procedure, and specifications as Ransburg may from time to time designate) for coating the items, all as set forth above.

2. Equipment and Supervision

At the time requested by User, Ransburg will ship prepaid to the above plant, for use of the Process, high voltage, atomizing liquid supply and electrical control equipment, and will furnish expert supervision for installing and placing it in operation. If Ransburg's

supervisor is required to make more than one trip to User's plant or is there delayed for any reason not chargeable to Ransburg, User will pay Ransburg $75.00 for each day of such extra trip or delay, plus transportation expenses incurred. User shall furnish all other labor, materials and equipment for the installation and use of the Process.

Ransburg will furnish replacements for any defective part of its equipment at the expense of (1) Ransburg, if the part becomes defective through ordinary wear and tear from proper use and if it is returned prepaid within 30 days after becoming defective, or (2) User, at Ransburg's applicable standard replacement charge, if it becomes defective through improper use or negligence of User, or is not returned within said 30 day period.

Ransburg's obligation to furnish equipment, supervision and replacement parts is subject to availability of the equipment and parts, to prior commitments, fires, strikes, acts of God, governmental decrees or actions, and any other causes beyond Ransburg's control, postponing or preventing performance.

3. Fees

User will pay Ransburg at Indianapolis, Indiana: (1) An initial fee of $ sixty days after shipment of Ransburg's equipment to User, or 30 days after its installation, whichever period expires earlier; and (2) For each calendar month during the term hereof, commencing upon completion of installation of the equipment or on the thirtieth day following shipment thereof, whichever occurs earlier, a monthly fee (pro-rated for any partial initial calendar month) equal to

At the request of either party the minimum monthly fee from time to time shall be adjusted commensurate with changes of not less than ten points from the value for January, 1956 of the Consumer Price Index, Large Cities Combined, All Items, of the Bureau of Labor Statistics of the U. S. Department of Labor, on the 1947-1949 base, or any successor thereto.

User will keep and make available for Ransburg's inspection during business hours permanent records of all information required for computing monthly fees. Within 10 days following each calendar month User will furnish to Ransburg a written report containing all information for computing the fee for that month, with User's computation and payment of the fee.

If shipment of the equipment is requested by User more than one year after Ransburg's acceptance of this agreement, Ransburg shall have the right to change the fees and terms of this agreement in conformity with its policy at that time.

4. Title and Use of Equipment

All equipment furnished by Ransburg shall remain its personal property and in User's possession until returned to Ransburg as herein provided. User will pay Ransburg for any loss of, or damage to, Ransburg's equipment while in the possession of User or its agents and upon termination of this agreement will at its expense promptly deliver the equipment, freight prepaid, to Ransburg at Indianapolis, Indiana, in as good condition as when received, except for ordinary wear and tear from proper use.

User will pay, or reimburse Ransburg for, any taxes or fees imposed by any governmental authority by

reason of the installation, possession, use, or location of any equipment or services furnished by Ransburg hereunder.

User will use the equipment and the Process in accordance with Ransburg's safety and operating recommendations, and will not make any use thereof except as herein provided. Ransburg shall have the right to enter User's premises during business hours to inspect the condition and use of the equipment.

5. Liability

Ransburg shall not be liable to User for damages resulting from the installation, servicing, presence, use or condition of Ransburg's equipment at User's plant. User indemnifies Ransburg against all claims of others for any damages resulting from the installation, servicing, presence, use, or condition of Ransburg's equipment at User's plant. Ransburg makes no warranty, express or implied, relative to the Process or equipment.

6. Term

This agreement shall be in effect from the date of acceptance by Ransburg until terminated as follows: (1) User may terminate as of the end of any calendar month or as of the date of return of Ransburg's equipment, whichever is later, upon 30 days' written notice to Ransburg; (2) Ransburg may terminate as of any date after three years from the acceptance date hereof, upon six months' written notice to User; or (3) Ransburg may terminate forthwith should User become insolvent or bankrupt or should any breach or default by User remain uncured for 20 days after written notice thereof from Ransburg, and in any such case Ransburg may enter User's premises and repos-

sess its equipment without it or its authorized representatives incurring any liability for trespass or other causes and without prejudice to its rights to recover amounts owing it hereunder or damages for breach of this agreement.

This written agreement constitutes the entire agreement between the parties, and no terms or understandings not herein contained (whether included in any purchase order or otherwise) shall be valid or binding unless contained in a writing signed by both parties. This agreement shall be governed by the law of Indiana.

Signed by User on (, 195

Accepted by Ransburg on , 195

(User) Ransburg Electro-Coating Corp.

By By

(Title) (Title)

PLAINTIFF'S EXHIBIT *ZZZZ-7.*

Binks Manufacturing Company
3114-40 W. Carroll Avenue, Chicago 12
VAn Buren 6-4200
Branch Offices In All Principal Cities.

July 25, 1956

Ransburg Electro-Coating Corporation
Barth & Sanders Streets
Indianapolis 7, Indiana

Attention: Mr. E. M. Ransburg

Gentlemen:

We acknowledge receipt of your letter of July 12, 1956 together with your standard license forms which you say cover a paint sprayer of the type we propose to market as noted in our letter of July 3, 1956.

We also note that you plan to return the early part of August and will get in touch with us.

In order to facilitate your consideration of the matter, we are enclosing our Print No. SK-661 dated 5-12-54 which illustrates the airless type of paint sprayer we have developed for electrostatically atomizing the paint.

We understand that you have used the form of license, like those you submitted to us, in licensing the trade under your Starkey Patent No. 2,685,536, but this form of license would not be satisfactory to us as a manufacturer of spray equipment.

Possibly, you may have some other form of license under the Starkey patent that would be acceptable to us.

Awaiting further word from you upon your return, we are

Very truly yours,
John W. Baur,
Chief Engineer, Std. Equipment.

Enclosure-1

PLAINTIFF'S EXHIBIT ZZZZ-8

PLAINTIFF'S EXHIBIT ZZZZ-9.

Exhibit "F".

Ransburg Electro-Coating Corp.
Ransburg

Telephone: MElrose 2-7513 Barth and Sanders Streets
Cable address: Ranscoat Indianapolis 7, Indiana

August 16, 1956

Binks Manufacturing Company,
3114-40 W. Carroll Avenue,
Chicago 12, Illinois.

Attention: Mr. John W. Baur,
Chief Engineer, Std. Equipment

Gentlemen:

Please accept my apologies for not replying earlier to your letter of July 25th, but several pressing matters have occasioned this delay after my return to Indianapolis.

We note that you advise that license forms Nos. 439 and 440 are not satisfactory. We will appreciate it if you will advise us what you have in mind.

Very truly yours,
Ransburg Electro-Coating Corp.,
E. M. Ransburg.

EMR/jp

PLAINTIFF'S EXHIBIT ZZZZ-10.

Binks Manufacturing Company
3114-40 W. Carroll Avenue, Chicago 12
VAn Buren 6-4200

Branch Offices In All Principal Cities.

August 22, 1956

Ransburg Electro-Coating Corporation
Barth & Sanders Streets
Indianapolis 7, Indiana

Attention: Mr. E. M. Ransburg

Dear Mr. Ransburg:

In response to your letter of August 16, 1956, we desire to advise you that we primarily interested in the manufacture of spray equipment for electrostatically spraying atomized paint without the use of compressed air. While in your letter of July 12, 1956 you state your licenses cover painting with this type of equipment, the submitted licenses, however, are not for the manufacture and sale of the actual spray equipment, but rather for the use of leased equipment.

What we are interested in is a license to make and sell equipment for this type of spray painting under your Starkey patent and the terms on which such a license would be available.

Awaiting your further advices in the matter, we are

Very truly yours

John W. Baur,
Chief Engineer, Std. Equipment.

PLAINTIFF'S EXHIBIT ZZZZ-11.

Exhibit "G."

Ransburg Electro-Coating Corp.
Ransburg

Telephone: MElrose 2-7513 Barth and Sanders Streets
Cable address: Ranscoat Indianapolis 7, Indiana

August 31, 1956

Binks Manufacturing Company
3114-40 W. Carroll Avenue
Chicago 12, Illinois

Attention: Mr. John W. Baur
Chief Engineer, Std. Equipment

Gentlemen:

In response to your letter of August 22 we wish to point out that our form No. 440 sent you with our letter of July 12 is not for the lease of equipment but rather is a license to use our process without reference to equipment.

It is a form for our granting a license directly to the user of the process because it enables us to establish fees on the basis of the requirements of the painting operation and the value of the coating material used.

Under certain circumstances this license form could possibly be modified and if you have some suggestions in that direction or any other proposals to make we shall appreciate receiving them.

Very truly yours,
Ransburg Electro-Coating Corp.,
E. M. Ransburg,
Vice President.

EMR:dh

PLAINTIFF'S EXHIBIT ZZZZ-12.

Binks Manufacturing Company
3114-40 W. Carroll Avenue, Chicago 12
VAn Buren 6-4200

Branch Offices In All Principal Cities.

September 12, 1956

Ransburg Electro-Coating Corporation
Barth & Sanders Streets
Indianapolis 7, Indiana

Attention: Mr. E. M. Ransburg

Dear Mr. Ransburg:

As we indicated to you in our previous letter of August 22, 1956, your submitted license form No. 440 is not acceptable to us. One reason for this is that it requires continuous periodic payments of royalties based on the extent of the coating material used by the equipment.

Our sales practice is such that any license agreements that we might enter into would have to require the payment of only one royalty at the time of each sale so that thereafter the customer's use of the equipment would be free of any further royalty payments.

In your letter you say that under certain circumstances your license can be modified and you ask us for our suggestions in that regard. Accordingly, would you consider granting a license requiring, in the instance of each sale of spray equipment, only a single royalty payment at a given rate of percentage of the sales price? If so, kindly advise us as to your terms for such a license.

Very truly yours,

John W. Baur,
Chief Engineer, Std. Equipment.

PLAINTIFF'S EXHIBIT ZZZZ-13.

Exhibit "H".

Ransburg Electro-Coating Corp.
Ransburg

Telephone: MElrose 2-7543
Cable address: Ranscoat Indianapolis 7, Indiana

September 21, 1956

Binks Manufacturing Company
3114-40 W. Carroll Avenue
Chicago 12, Illinois

Attention: Mr. John W. Baur
Chief Engineer, Std. Equipment

Gentlemen:

This is in reply to your letter of September 12 advising that our method of charging in relation to the use of the process is unacceptable to you and asking if we would consider granting a license in which the royalty is based solely on the sales price of the equipment. Granting licenses on this basis would require a complete change in our marketing policy and a change of all of our licenses now in effect, as otherwise a large part of our licensees would be treated unfairly. We also believe that the system you suggest is not satisfactory for determining the proper value for the use of the process.

In view of the foregoing we trust you can readily understand why we feel that we cannot comply with your request. We want you to know that licenses are available to your customers for painting with our method and we assume

you will not furnish the equipment which has been the subject of this correspondence to such customers unless they are licensed by us.

Very truly yours,

Ransburg Electro-Coating Corp.,

E. M. Ransburg,

EMR:dh *Vice President.*

PLAINTIFF'S EXHIBIT AAAAA.

December 11, 1956

Allegheny Ludlum Steel Corp.
2020 Oliver Building
Pittsburgh 22, Pennsylvania

Attn: Mr. A. B. Wadsworth
Asst. Purchasing Agent

Gentlemen:

This letter is pursuant to our recent telephone conversations with Mr. Wadsworth and Mr. Ely regarding Ransburg Electro-Spray agreement No. 6482 which we have proposed for Allegheny Ludlum Steel Corp. We are agreeable to amending agreement No. 6482 as follows:

A. The equipment supplied by Ransburg under agreement No. 6482 will be installed in Allegheny Ludlum's plant on an initial one year's trial basis, the year to commence with the date of installation of the equipment. During the one year trial period, the monthly fees shall be a flat $175.00 per month. If, prior to the end of this one year trial period, Allegheny Ludlum notifies Ransburg in writing that they are not satisfied with the installation and therefore terminate the agreement, Ransburg will refund to Allegheny Ludlum

one-half of all initial and monthly fees paid by Allegheny Ludlum under agreement No. 6482.

B. If during the aforesaid one year trial period, Allegheny Ludlum notifies Ransburg in writing that they are not satisfied with the original installation and that Allegheny Ludlum then desires to use the Ransburg No. 1 Process of electrostatic spray coating (using compressed air spray guns), Ransburg will ship to Allegheny Ludlum's plant, and supervise its installation, equipment for using the Ransburg No. 1 Process at no additional charge to Allegheny Ludlum, except that Allegheny Ludlum will furnish the necessary spray guns, air controls, etc. which are normally supplied by a user of the Ransburg No. 1 Process. Allegheny Ludlum will also return to Ransburg all items of the original installation not required for the subsequent No. 1 Process installation. The No. 1 Process installation provided herein shall be on the same one year's trial basis as set forth in A. above.

C. Should Ransburg exercise its right of termination under paragraph 6 (2) during the fourth year of the agreement, Ransburg will refund one-third of the initial fee paid by Allegheny Ludlum under this agreement; and should Ransburg exercise said right during the fifth year of the agreement, Ransburg will refund one-fourth of said initial fee. No refund shall be made in case of termination by Ransburg after the expiration of said fifth year.

D. Ransburg is the owner of the following patents relating to its No. 1 Process:

2,442,986	2,486,877	2,567,781.
2,466,906	2,550,657	2,730,460

Ransburg is the owner of the following patents relating to its No. 2 Process:

2,651,287	2,695,002	2,728,607
2,658,009	2,706,964	2,728,689
2,658,472	2,718,477	2,733,171
2,684,656	2,723,646	2,764,712
2,685,536	2,728,606	

In addition, Ransburg is the owner of the following patents in the field of electrostatic coating which are not limited to any particular one of its electrostatic coating processes:

2,247,963	2,463,422	2,546,701
2,270,341	2,465,128	2,551,035
2,334,648	2,509,276	2,553,724
2,417,798	2,509,277	2,559,225
2,421,787	2,509,448	2,568,611
2,425,652	2,526,763	2,632,716
2,428,991	2,531,542	2,636,471
2,446,953	2,544,896	2,650,329
2,655,128	2,724,661	2,748,018
2,662,833	2,729,191	2,751,564
2,690,730	2,730,461	2,751,851
2,697,411	2,730,988	2,752,883
2,698,814	2,731,589	2,754,226
2,703,549	2,736,671	2,754,227
2,711,155	2,744,218	2,761,544
2,723,921	2,744,033	2,764,125

Although we feel that the possible harm from doing so would be negligible, we do not, give patent infringement indemnification on our No. 2 Process. We feel that our customers, as well as we, benefit from this policy. Although our developments permit us to adapt the process to any one of several different courses, we are proposing, as is our policy, our very latest developments to your company

as to which, from a patent standpoint, we cannot be assured at this time of 100% freedom of action. In the remote event that patent infringement should ever be alleged at a future date by some third party, we are then free to suggest to our customers some non-infringing modification of electrostatic coating. If we were to employ any other policy, we could conceivably be placed in the position of having some customer proceed to use the process at heavy expense to us and unwilling to adopt any suggestion regarding a modification which would avoid the possibility of infringement.

In all our years in developing and marketing electrostatic coating going back into the 1930s, during which time we have prosecuted a substantial number of patent applications, we have not run across any patent or application which, in our opinion, could possibly be infringed by your use of our No. 2 Process under agreement No. 6482. We realize it is general practice for a vendor of consumer products to give patent infringement indemnification; however, we do not believe it customary for the licensor under a patent position to give such indemnification. In this regard we refer to the type of license agreements issued by firms such as DuPont and R. C. A. for the use of patented manufacturing processes on the one hand and the manufacture of electronic equipment on the other.

In regard to the suggestion that Ransburg ought not to be able to terminate until later than the three year period provided by paragraph 6 (2), we feel the amendment proposed in paragraph C, above is more than fair. We can advise you that we have never had a policy of arbitrarily terminating our customer agreements at the end of three years or at any other time. In fact, with one exception involving a company which still remains a satisfied customer of ours, we have never terminated a customer agreement under paragraph 6 (2).

We wish to assure you that all of our outstanding agreements with such conservatively managed companies as General Electric, Westinghouse, I. B. M. and Bethlehem Steel are substantially identical to the agreement which we have proposed for Allegheny Ludlum, and that these outstanding agreements specifically do not contain a patent infringement indemnification clause and are terminable by us after a three year period.

We trust that the foregoing amendments will be acceptable to your company and if agreement No. 6482 as amended above is satisfactory to you, we would appreciate your signing and returning to us three copies of the agreement, as well as three copies of this letter. We will then sign all copies and return a copy of each for your files so we may then proceed with plans for the installation of our equipment in your plant.

Very truly yours,

Ransburg Electro-Coating Corp.
Merrill N. Johnson

MNJ:mk

cc Mr. James Ely, Patent Attorney
Allegheny Ludlum Steel Corp.
River Road
Brackenridge, Pennsylvania

Agreed to this day of
, 195 .
Allegheny Ludlum Steel Corp.
By

Accepted this day of
, 195 .
Ransburg Electro-Coating Corp.
By

PLAINTIFF'S EXHIBIT NO. CCCCC.

May 16, 1952

General Electric Company
Schenectady, New York

Attention: Mr. F. L. Neuhauser
Patent Department

Dear Mr. Neuhauser:

Pursuant to our telephone conversation of May 14, we are pleased to enclose sample copy of our proposed agreement for an installation for coating your automatic clothes washers and dryers in Louisville, Kentucky. Also enclosed is a proposed amendment to Paragraph 11 titled Future Inventions, which limits this clause to your Major Appliance Division.

Please note that we have stipulated an initial fee in Paragraph 10 in the amount of $26,250.00 and a minimum monthly fee of $500.00. These figures are sufficient for the installation of triple heads in the event you wish to modify the Future Inventions clause from the enclosed proposed amendment. In the event the Future Inventions clause and the 30 day minimum fee period are satisfactory to you as proposed, these figures can be reduced to $17,000.00 and $320.00 per month.

We shall appreciate your advice.

Yours very truly,
Ransburg Electro-Coating Corp.
E. M. Ransburg

EMR:eh
Enclosures
(In Duplicate)
Blind CC: Mr. E. A. Zahn
General Electric Co.
Louisville, Kentucky

PLAINTIFF'S EXHIBIT NO. GGGGG.

490 Mr. C. V. Boys on the Production, Properties.

There is a process by which threads may be made which is natural in that natural forces only are employed, and the thread is not in any way touched during its production. This is the old, but now apparently little-known experiment of electrical spinning. If a small dish be insulated and connected with an electrical machine and filled with melted rosin, beeswax, pitch, shellac, sealing-wax, Canada balsam, guttapercha, burnt india rubber, collodion, or any other viscous material, the contents will, if they reach one edge of the dish, at once be shot out in the most extraordinary way in one, two, or it may be a dozen threads of extreme tenuity, travelling at a high speed along "lines of force." If the material is very hot, the liquid cylinders shot out are unstable and break into beads, which rattle like hail on a sheet of paper a few feet off. As the material cools, the beads each begin to carry long slender tails, and at last these tails unite the beads in twos and threes; but the distance between the beads is far greater than that due to the natural breaking of a cylinder into spheres, as after the first deformation of the surface occurs which determines the ultimate spheres the repulsive force along the thread continues, and drags them apart many times their natural distance. As the temperature continues to fall and the material to become more viscid, the beads become less spherical, and the tails less slender, and at last a perfectly uniform cylindrical thread is formed. If sealing-wax is employed, and a sheet of paper laid for it to fall on, the paper becomes suffused in time with a delicate rosy shade produced by innumerable fibres separately almost invisible. On placing the fingers on the paper, the

web adheres and can be raised in a sheet as delicate and intricate as any spider's web.

It is interesting to see how these fibres fly to any conducting body placed in their path. If the hand is held there it is quickly surrounded by a halo of the finest threads. If a lighted candle is placed in the way, the fibres are seen by the light of the candle to be rushing with the greatest velocity towards it, but when a few inches off they are discharged by the flame, they stop, turn round, and rush back as fast into the saucer whence they came. The conditions for the success of this beautiful experiment are not very easily obtained.

146. Spinning sealing wax.—Fasten on to a thick wire a piece of sealing wax, about one inch long, by heating it, and thrusting the wire into it. Put the other end of the wire into a hole, either at the end or side of the conductor, so that the wax shall be at some distance off. Underneath where the wax is, either on the table or the floor, place a sheet of brown paper, merely to catch any drops which may fall when the wax is inflamed. Provide yourself also with a lighted candle, and a sheet of white paper. Direct your assistant (for in this experiment you must have one), to turn the machine, and stop it exactly at the time you may desire. Then standing near the wax, hold the white paper 4 or 5 inches from it, and light the sealing wax. When well lighted, blow it out, and at the same instant let the machine be turned, and exceedingly fine threads of wax will be thrown off, and collected on the white paper, as long as the wax remains melted. Stop the machine, light, blow out the wax, and turn the machine as before—more of the filaments will be thrown off, and thus any quantity may be collected, and if scraped together by the point of a pin, it will resemble the finest wool, such as cannot be procured by any other means.

ZELENY, Proceedings of Cambridge Philosophical Soc.
Vol. 18, pp. 71-83 (1915).

On the Conditions of Instability of Electrified Drops, with Applications to the Electrical Discharge from Liquid Points.

By JOHN ZELENY, B.A., Ph.D., Professor of Physics, University of Minnesota, U.S.A. (Communicated by Professor Sir J. J. Thomson.)

[*Read* 9 November 1914.]

IN a recent paper on the electrical discharge from liquid points*, a description is given of certain motions which are observed at the surfaces of such points when an electric current starts to flow from them.

The present paper is concerned with a study of this surface behaviour under a variety of conditions, and an explanation of the phenomena is given.

Description of Experiments.

1. A discharge point of the kind in question consists of a small drop of liquid at the end of a tube, usually only a fraction of a millimetre in diameter. The drop may be made to assume a hemispherical form by applying a suitable pressure to the liquid inside of the tube.

The arrangement of the apparatus used is shown in diagram in Figure 1. The discharge point A was made of glass or quartz and the current from it passed to the brass disc B (usually placed at a distance of 1·5 cms.) and then to earth through the galvanometer G. The reservoir C is joined to the bent glass tube D by the rubber tube E, which permits the reservoir to be raised or lowered for adjusting the pressure inside of the drop of liquid at the end of A. The liquid in the tubes is connected, by the wire F, to the source of potential and an electrostatic voltmeter.

In many of the experiments to be considered the essential parts of the apparatus were enclosed in a metal vessel to permit of work with various pressures and with different gases.

Unless otherwise stated, it will be understood throughout the paper that a positive discharge from the point is being considered.

2. When water is the liquid used in air at atmospheric pressure, it is noted, when the end of the point A is observed with a microscope, that as the potential is gradually raised, the surface of the drop being kept hemispherical by constant adjustment of the reservoir C, finally at a certain voltage the surface of the drop suddenly snaps back into a more flat position and the galvanometer indicates a momentary current. After adjusting the pressure so as to bring the surface to its first position, the phenomenon is only

* J. Zeleny, *Physical Review*, N.S., Vol. 2, p. 69, 1914.

peated after the potential has been increased above its former value. On continuing the procedure, the liquid surface soon takes on a continuous up and down motion, a current of like period passing to the plate. At last the oscillations become too rapid to follow and the top of the meniscus simply appears blurred. On increasing the voltage further, the outline of the meniscus suddenly becomes perfectly distinct and the current becomes steady, a telephone receiver in the circuit now giving no sound. At this stage of the discharge the luminosity is confined to a very thin coating on the liquid surface, whereas in the intermittent stage a faint light was observed extending, in the form of a brush, a good portion of the distance to the plate.

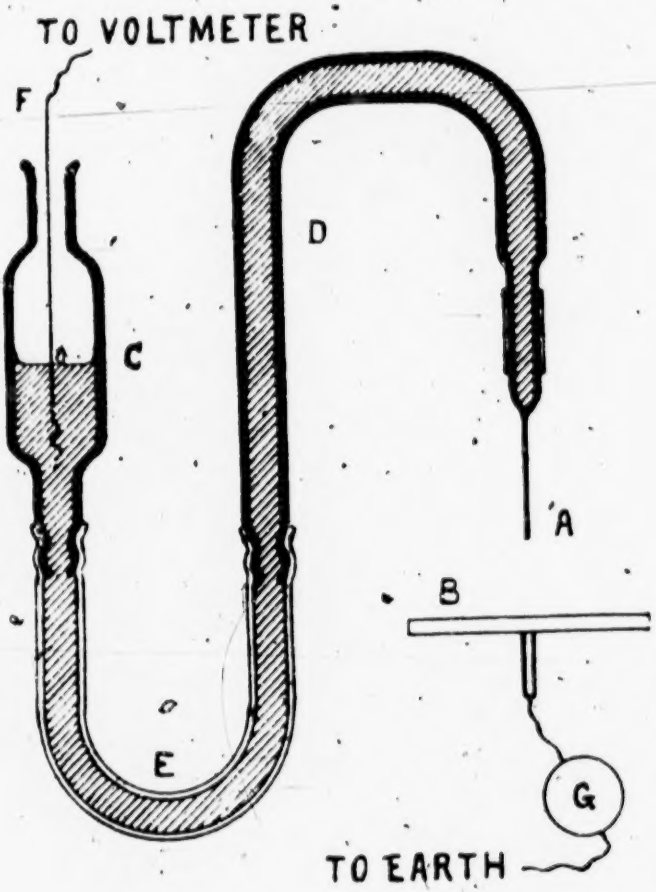


Fig. 1.

3. Experiments with water surfaces in air at reduced pressures show that the intermittent stage of the current is not obtained at pressures below about 60 cms. of mercury. In this region the current begins with a jump to a value of some magnitude, the meniscus of the liquid snapping back simultaneously to a lower

position; but the current may be maintained at a lower voltage than that at which it began.

4. A water-surface in carbonic acid at atmospheric pressure shows the same behaviour at the lower potentials as that described in § 2 when air was used, but as the voltage is raised the blurred meniscus suddenly changes in this case not to a distinct hemispherical form as before but into a steady cone with a faint dark line extending outward from the apex for some distance, as shown by the drawing "*a*" in Fig. 2.

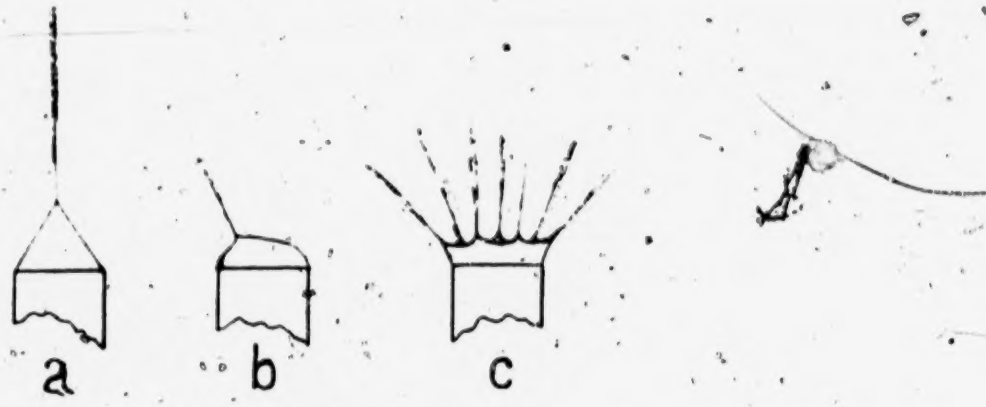


Fig. 2.

The height of the cone changes with change in the liquid pressure and when this is diminished sufficiently the form becomes that shown at "*b*" in the figure, where the small pointed portion at one side is to be noted as well as the faint dark streak extending out from it. The cone-shaped meniscus persists over a rather narrow range of voltages, and when the upper limit of this range is reached the surface again becomes agitated.

5. The potential at which the current ceases from a water surface in carbonic acid was found to be almost if not exactly identical with that at which the current ceases from the same point in air. Carbonic acid, however, shows the unique behaviour that this voltage remains unchanged for pressures down to about one-third of an atmosphere, below which pressure the intermittent stage of the current disappeared. The conical meniscus was not obtainable for pressures much below the atmospheric pressure.

6. In hydrogen no intermittent stage of the current was observed with a water surface whatever the pressure of the gas (below an atmosphere). The current begins suddenly with a considerable magnitude, as described in § 3 for air at reduced pressures.

7. An alcohol surface, both in air and in carbonic acid, was found to behave in the same way as a water surface does in carbonic acid, both as regards the oscillations with an intermittent current, and as regards the subsequent conical form of meniscus. For voltages well above that for which the steady conical surface changed into a blurred agitated one, the appearance became that shown at "*c*," Fig. 2, where there are a number of fine points with their attendant dark streaks arranged along the circumference of a raised edge.

For voltages at which the oscillations of the meniscus first appeared, these oscillations had a much smaller amplitude with alcohol than they did with water, and the quantity of electricity reaching the plate at each movement of the meniscus was also much less in the case of alcohol.

The behaviour with alcohol remained quite unchanged as the pressure was reduced below that of the atmosphere, in both air and carbonic acid. The cone form of meniscus was observed in air at a pressure of 12 cms. of mercury and in carbonic acid at a pressure of 25 cms. of mercury, these being the lowest pressures used with these gases. Moreover the potentials at which the current ceases were found to be the same in both gases and for all of the pressures used. This potential was, however, only about six-tenths of that at which the discharge stopped in air.

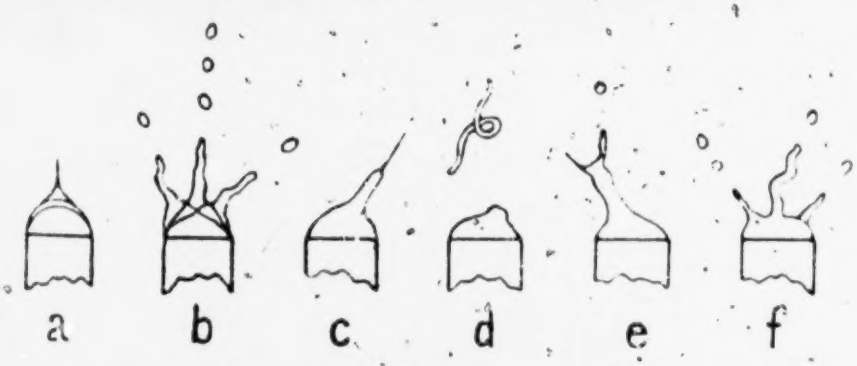


Fig. 3.

8. When the cone-shaped discharge surface of alcohol was examined with a microscope magnifying about 50 diameters in the instantaneous light of a Leyden jar spark, the dark streak seen along the prolonged axis of the cone was not resolved into drops. When examined without a microscope in weak continuous light, a form of brush of considerable angle was faintly seen extending outward from the end of the cone; but this brush showed no luminosity when examined in the dark. A luminous brush of the same form as this one was previously observed (§ 2) at the end of a hemispherical drop of water at each of the intermittent discharges from it.

9. When an alcohol meniscus is examined under instantaneous illumination as a current first starts to flow from it (i.e. during the intermittent stage), some of the shapes that the meniscus is seen to assume are indicated by "*a*" in Fig. 3. The peaked form tapers down to a point of vanishing diameter.

With voltages at which the surface shows a great deal of agitation when viewed in ordinary light, it is seen under instantaneous illumination that large masses and threads of liquid are pulled out of the surface. Some of the forms which have been observed are shown in Fig. 3 by the drawings "*b*," "*c*," "*d*," "*e*" and "*f*."

10. After the current from the conical form of discharge with alcohol has been allowed to flow for some time, the plate underneath the point becomes wet with a disc of liquid which has a diameter about equal to the distance between the point and the plate. From the amount of liquid thus carried over, it appeared possible that the whole current from the alcohol point might result from the charges carried by minute drops leaving the charged surface and impinging on the plate.

Experiments to test this point were made on the conical form of discharge in the open air, by noting what effect a blast of air, blown at right angles to the electric field between the point and plate, would have upon the current received by the plate. The receiving plate was divided into two parts, one of which was earthed directly and the other of which was earthed through a galvanometer. When the discharge point was placed directly over the division line between these two parts and a moderate blast of air from a foot-bellows was directed along the surface of the plate from the part connected to the galvanometer towards the second part, the current reaching the galvanometer was reduced to zero although the blast had no appreciable effect upon the discharging surface. When the point was moved so as to be over a portion of the plate at some distance from its edge, the same stream of air reduced the current flowing through the galvanometer but did not completely destroy it.

Under similar circumstances a current from a metal point, carried as it is by gaseous ions, would not have been appreciably affected by the stream of air which was used. It is evident, therefore, that all of the current in this case was carried by drops of liquid, much larger than ordinary ions.

A rough estimate of the size of these drops may be made from the observation that with a current of 2000 electrostatic units the conical point discharged alcohol at the rate of 10^{-4} cubic centimetres per second. The point had a radius of 0·0189 cm., was situated ·3 cms. above the plate and was maintained at a potential of 3300 volts. The electric surface density on the drops must be

ss than what would correspond to a drop having the potential of the discharge point, and so an estimate was made based on later considerations and it was found that the radius of the drops is probably between 10^{-5} cms. and 10^{-4} cms. Accordingly many millions of these drops must be formed every second under the conditions existing in the conical form of discharge from an alcohol surface.

The ejection of these comparatively small pieces from the surface is evidently quite a different matter from the outflow of large drops from the tube, and is doubtless the result of a state of instability of the surface.

Conditions for Instability.

11. The conditions that are necessary for a charged surface to become unstable are exemplified by considering the equilibrium equation for a spherical drop

$$\frac{2T}{r} - p - 2\pi\sigma^2 = 0 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1),$$

where T is the surface tension, r the radius of curvature, σ the electric surface density, and p the excess-pressure inside the drop over that outside.

The equilibrium becomes unstable when, p remaining unchanged, a small outward displacement of a portion of the surface increases the outward force due to σ, because of the increased curvature produced, more than it does the restoring pressure arising from surface tension.

To obtain a solution by this simple method, it is necessary to know not only the shape of the surface but also the distribution of the charge on it, both before and after the displacement in question.

The surface of a small drop at the end of a vertical tube is one of revolution and is nearly spherical. Let us consider the surface to be an ellipsoid of revolution about the axis of the tube, and consider a displacement arising from an elongation of the rotation axis. This elongation might result from liquid flowing into the drop from the tube above, the minor axis remaining unchanged, or it might result from a contraction of a portion of the drop near its place of attachment, the change of shape at the apex approximating more or less closely that of an ellipsoid of constant volume. The calculation of the distribution of the charge on any shaped drop suspended at the end of a cylinder is rather difficult. However it is of interest to consider some ideal cases of isolated, charged, ellipsoidal drops, undergoing changes of shape as a whole in one of the two ways mentioned above, namely by keeping the minor axis

of the generating ellipse constant and hence having a variable volume, or by keeping the volume constant.

Let "c" be the semi-axis of rotation and "a" the transverse semi-axis, and consider in each case the equilibrium of a portion of the surface at the end of the axis of rotation inasmuch as experiment showed the instability to begin at this place on the drops examined.

12. First, consider the volume of the ellipsoid constant and that it has a constant charge Q. Equation (1) becomes

$$\frac{2T\epsilon}{a^2} - p - \frac{Q^2}{8\pi a^4} = 0 \quad \ldots\ldots\ldots\ldots\ldots\ldots (2).$$

Putting the first derivative equal to zero, to get the relation for the limit of stability, and remembering that a^2c = a constant,

$$Q^2 = 16\pi a^2 cT \quad \ldots\ldots\ldots\ldots\ldots\ldots (3).$$

Equation (2) shows that for this value of Q, the excess pressure, p, inside the drop vanishes.

For a sphere, equation (3) becomes

$$Q^2 = 16\pi a^3 T \quad \ldots\ldots\ldots\ldots\ldots\ldots (4),$$

a result obtained long ago by Lord Rayleigh*.

If Q and "a" are taken as constant, there is no instability, but for every value of Q there is a value of "c" which gives stable equilibrium.

Since in the drops experimented upon the potential V, and not Q, was maintained constant, cases will next be considered with that supposition.

13. Consider V and "a" constant. Equation (1) becomes

$$\frac{2T\epsilon}{a^2} - p - \frac{c^2e^2V^2}{2\pi a^4 \log^2 \frac{1+e}{1-e}} = 0 \quad \ldots\ldots\ldots\ldots (5),$$

the ellipsoid being considered prolate, and "e" being the eccentricity of the generating ellipse. The relation at the limit of stability is

$$V^2 = 2\pi a T \frac{\sqrt{1-e^2}\log\frac{1+e}{1-e}}{\log\frac{1+e}{1-e} - 2e} \quad \ldots\ldots\ldots\ldots (6),$$

which becomes for a sphere, at the limit $e = 0$,

$$V^2 = 24\pi a T \quad \ldots\ldots\ldots\ldots\ldots\ldots (7).$$

* Lord Rayleigh, *Phil. Mag.*, Series 5, Vol. 14, p. 184, 1882.

14. Lastly, considering V and the volume of the ellipsoid constant, instability sets in when

$$V^2 = 4\pi a T \frac{\sqrt{1-e^2}\log^2\frac{1+e}{1-e}}{(1+e^2)\log\frac{1+e}{1-e} - 2e} \quad \ldots\ldots\ldots\ldots(8),$$

and this expression, at the limit of a sphere, reduces to

$$V^2 = 12\pi a T \ldots\ldots\ldots\ldots\ldots\ldots(9).$$

It is seen that under the conditions here taken, when instability begins, the pressure inside the drop is greater than that outside the drop, whereas under the conditions assumed in § 13 the opposite is the case.

In the experiments with hemispherical drops of water at the ends of tubes it was observed that when instability commenced there was an excess of pressure on the inside of the drops and this was approximately equal to one-tenth of the whole pressure caused by surface tension alone. With a low meniscus however, the pressure inside the drops, under the same conditions, was found to be less than that outside.

It may be said that the values of V^2 given by equations (6) and (8) differ very little from those given by equations (7) and (9) respectively, for values of e as high as 0·2 or more.

15. The preceding results, and some further considerations, lead to the general expression (applicable to drops on the end of a tube)

$$V^2 = CaT \quad \ldots\ldots\ldots\ldots\ldots\ldots(10),$$

as giving the potential at which instability commences, C being a constant depending upon the shape of the drop and the manner in which it undergoes axial changes. We may test the expression experimentally by finding how the potential necessary for instability is dependent upon the size of the tube and upon the surface tension of the liquid used.

Experimental Results.

16. As the first example we will take some results obtained for water and alcohol. The potentials at which these surfaces ceased to be unstable were found to be 4050 volts and 2350 volts respectively. In agreement with our formula, the squares of these numbers are seen to be proportional to the surface tensions of the two liquids (taking 72 for the value of the surface tension of water and 24 for that of the alcohol used, which was nearly absolute).

As a further test of the surface tension factor in formula 10,

results, obtained some time ago with a number of liquids, are given in Table I for the potentials at which the surface oscillations, indicative of instability, ceased as the voltage was decreased. The list of liquids is confined to those which have an appreciable conductivity and still do not leave a solid residue on evaporation. The experiments were done in the open air (pressure = 74 cms. of mercury) with the point at a distance of 1·5 cms. from a plate.

TABLE I. Instability Potentials.

Radius of point, 0·0250 cm. Average temperature, 23° C.

Substance	Density	Surface tension	Instability potential	C
Acetone	0·790	24·9 dynes/cm.	9·30 electrostatic units	140
Methyl alcohol	0·804	25·3 "	9·25 "	137
Ethyl alcohol ...	0·812	25·3 "	9·25 "	137
Water	0·998	72·0 "	15·90 "	140
Acetic acid	1·053	30·0 "	9·67 "	125
Glycerine	1·259	65·2 "	15·17 "	142
Chloroform	1·483	27·0 "	10·17 "	153

Column 2 gives the densities of the liquids named in column 1. Column 3 gives the values of the surface tensions of the liquids, determined while in the apparatus by measuring the pressure in an uncharged hemispherical drop. These values are not very accurate as the readings for them were taken incidentally only, as the experiments were made for another purpose for which the surface tensions were not needed. The value given for the surface tension of glycerine was taken from tables, as a difficulty was found in the direct measurement owing to its high viscosity; and the value for methyl alcohol is taken the same as that of ethyl alcohol since no direct measurement was made and the two substances have very nearly the same value.

Column 4 gives the observed instability potentials expressed in electrostatic units. The last column gives the values of the constant C in expression (10), as calculated for each liquid from the tabulated values of V, a, and T.

When account is taken of the rather large experimental errors in the determinations of T, the values of C are nearly enough alike to show that the squares of the potentials at which instability begins are proportional to the surface tensions of the liquids.

17. For showing the dependence of V upon the radius of the discharge point, reference is made to a table of electric intensities, f, given in a previous paper (*loc. cit.*, p. 88) which were determined at the surfaces of water drops ranging in radius from 0·0146 cm.

to 0·0543 cm. when the oscillations in question and the currents from the points were observed to stop. Since the current from a point also starts at this stage it was then thought that the values of f obtained were those requisite for starting a discharge, but it is known from the considerations given in this paper that the oscillations indicate rather the beginning of instability at the surface, although with water the two actions start at potentials which are not greatly different.

The results, in the table referred to, show that $f\sqrt{a}$ = a constant, and putting $f \propto \frac{V}{a}$, we get $V^2 = a \times$ a constant, which is the relation in expression (10).

Taking the average value of the constant C from Table I, expression (10) becomes $V^2 = 140aT$ and for the sake of comparison with the expressions obtained in §§ 13 and 14, this may be put in the form $V^2 = \frac{16\pi aT}{0{\cdot}36}$.

It was found experimentally (*loc. cit.*, p. 74) that the surface density on the end of a hemispherical drop attached to the end of a tube, with a plate at a distance of 1·5 cms., is only about six-tenths of that on an isolated sphere of the same diameter and having the same potential. The square of this number, or 0·36, must be introduced into the denominators of the theoretical expressions in §§ 13 and 14 to permit of their comparison with experimental results on drops at the ends of tubes. The experimental coefficient 16 is seen to be between the two coefficients 24 and 12 obtained in §§ 13 and 14 respectively, and this may be taken to indicate that the experimental drop changes form in a way intermediate between that of keeping a constant volume and that of keeping a constant cross-section.

Discussion.

18. The relation of the potential at which the surface of a charged drop becomes unstable, to that at which an electrical discharge starts, will now be considered. A study of a table giving surface tensions indicates that in air at atmospheric pressure the limit for instability is reached on the surface of drops of all substances which are liquid at room temperature, with the exception of mercury, before a potential is reached at which an electrical discharge through the air begins. But in hydrogen for example the potential for an electric discharge from a water surface is smaller than the potential for the beginning of instability.

The size of the tube on which the drop is formed is of no great consequence for the relationship in question, since it has been shown

* J. Zeleny, *Physical Review*, Vol. 25, p. 317, 1907.

that for metal points with a radius greater than 0.025 cm. the voltages at which a discharge begins are proportional to the square roots of the radii of the points, which is the same relation as that obtained above for the beginning of instability with liquids, although for points smaller than the value given the voltages necessary for starting the current are larger than this relation would indicate.

After a discharge has started from a surface, a large increase in the voltage may not bring on instability, because while a current is flowing the electric intensity at the surface varies but little with the voltage used (*loc. cit.*, p. 85).

Since the potential necessary for a discharge depends upon the pressure of the gas while the potential for the beginning of instability does not, it is possible to have instability begin first in a gas at atmospheric pressure and to have a discharge begin first in the same gas at reduced pressures.

19. With water surfaces in air at atmospheric pressure, the potential at which a discharge starts is only a few per cent. higher than the potential at which instability sets in, and as the potential is gradually raised above this latter value the instability at the surface stops suddenly and a steady current flows from the surface. This indicates that either the surface tension is increased by the current or the electric intensity at the surface falls slightly as soon as the current starts. There is some evidence for both views.

A sort of electrical discharge is present with water surfaces as soon as instability begins as is shown by a faint luminosity seen extending some distance from the point, but apparently this discharge is brought on by the changes of shape caused by the instability and may be confined altogether to the surfaces of the flying drops.

The conical form of discharge surface, seen when carbonic acid is used with a water surface or when liquids of low surface tension are used, makes its appearance over a certain range of voltages in cases where the instability voltage is considerably lower than the discharge voltage. As the liquid is being pulled out rapidly from the tip end of the meniscus in the form of threads, the surface distribution over the rest of the meniscus becomes altered so that equilibrium necessitates the conical form of surface. This form of surface should be obtainable also with a water surface in air, if the discharge potential were raised sufficiently. The latter condition can be produced by increasing the pressure of the air, and on trial it was found that the conical form came on as predicted when the pressure of the air was increased but 10 cms. of mercury above that of the atmosphere.

The presence of a little alcohol vapour in the discharge vessel also made the conical form of surface appear, by lowering the surface tension of the water.

20. The facts noted in §§ 5 and 7 that with water in carbonic acid and with alcohol in air or carbonic acid, the oscillations of the meniscus began at a potential in each of the cases which was independent of the pressure of the gas over a considerable range, are explained by the discharge potential being much higher at atmospheric pressure than the instability potential, so that even at much lower pressures the discharge voltage was not reduced enough to be below the potential for instability.

The successive individual discharges, mentioned in § 2, which are observed at increasing potentials when a discharge is first started from an old water surface, are doubtless caused by the surface having a low surface tension owing to contamination. As pieces of the liquid are pulled away, the contamination gradually disappears and a higher and higher voltage is necessary to produce instability. The falling of the meniscus after each of these discharges shows that an increase in the surface tension has taken place.

At a later stage where the surface undergoes continuous oscillations at a given voltage, a different cause doubtless enters, the surface becoming stable intermittently owing to electric shielding by the material pulled out of its surface.

Sporadic discharges like those considered above are often noticed with metal points at voltages far below the final discharge potential, and it is possible that something of the same nature takes place there as in these cases, a part of the adsorbed layer of gas and water being pulled off from the surface at each discharge.

21. The expression given in § 15 for the potential at which instability begins applies to cases where the medium between the point and plane is a gas, and thus having a dielectric constant of approximately unity. If the experiment were done in a non-conducting fluid not miscible with the liquid of the drop, the expression would have to include k, the dielectric constant of the new medium, and would be written $kV^2 = C\alpha T$. Evidently, the dielectric constant could be determined in this way by measuring the surface tension between the two liquids and the voltage at which instability starts.

22. It follows from the results recorded in this paper that before a potential is reached which would result in lightning striking a tree, for example, the leaves, if wet, will discharge water from their edges in the form of minute electrified drops which will form an upward shower tending to neutralize the electric field. But since the discharge potential is so near to the instability potential for water, it is not likely that this phenomenon plays any important part in the atmospheric electricity during storms.

The condition for instability also sets a limit to the possible size of charged rain drops, but the charge on drops of the usual size would have to be very large indeed before instability would arise from this cause.

Summary.

23. Certain motions of agitation, which are observed at the surfaces of drops of liquid when an electric current starts to flow from them, are described and the conditions under which the movements occur are studied (§§ 2—9).

It is shown that in some cases (§ 10) the observed current is all carried by minute charged drops, formed of liquid which has been pulled from the discharging surface.

The ejection of these masses from the surface occurs when the stabilizing effect of surface tension is overcome by the instability caused by the electric forces (§ 11).

A relation between the potential at which instability begins, and the dimensions of the drop and the surface tension of the liquid, is derived for some ideal cases (§§ 11—14), and a formula applicable to the drops used in the experiments is given (§ 15).

In agreement with theory, the experiments show that the square of the potential at which instability begins is proportional to the surface tension of the liquid (§ 16) and to the radius of the tube on which the drop is formed (§ 17).

In air at atmospheric pressure, instability sets in before the true electric discharge through the gas begins, for all liquids except mercury (room temperature assumed) (§ 18).

In a gas like hydrogen or in air at reduced pressures, the electric discharge may be obtained in many cases before instability occurs (§ 18).

An explanation of the observed effects is given (§§ 19, 20), and some outside applications of the results obtained are considered (§§ 21, 22).

A part of the work on this investigation was done at the Cavendish Laboratory, and I wish to express here my thanks to Prof. Sir J. J. Thomson for his kind and helpful interest in the work and for placing the necessary apparatus at my disposal.

THE

PHYSICAL REVIEW.

INSTABILITY OF ELECTRIFIED LIQUID SURFACES.

By John Zeleny.

IN a recent paper[1] a brief description was given of the appearance of a liquid surface undergoing disintegration owing to instability arising from an electric charge.

The observations recorded were made in connection with some experiments on the electric discharge from liquid surfaces and the work was confined to eye observations, through a microscope, of the surface in question when this was illuminated by the light of a spark from a Leyden jar. Some of the phenomena appeared to be of sufficient interest to warrant the making of a more accurate record of them by the aid of photography, and a few results obtained by this method are described in this paper.

The apparatus used for getting the electrified surface was similar to that used previously and for details reference is made to the paper mentioned. Briefly, the apparatus consisted of a vertical glass tube, 0.02 mm. in diameter, joined from its upper enlarged end by rubber tubing to a reservoir of the liquid. A drop of liquid at the lower end of the small glass tube was the part under observation. The liquid was charged to several thousand volts from a static machine, and a grounded plate was placed about 2 cm. below the end of the glass tube. Ethyl alcohol was used for nearly all of the experiments inasmuch as water is not a convenient liquid for showing some of the phenomena, because, owing to its high surface tension, the potential at which instability of its surface is first obtained in air at atmospheric pressure is nearly the same as that at which an electric discharge begins.

2. The source of light mostly employed in taking instantaneous pictures of the liquid was a condenser discharge between magnesium electrodes in air. For some of the exposures the spark was passed through mercury

[1] Proc. Camb. Philos. Soc., 18, p. 71, 1915.

vapor at atmospheric pressure in an arrangement similar to that described by C. T. R. Wilson.[1]

An induction coil was used for charging the Leyden jars, and this was provided with a rotary, mercury-jet interrupter which could be operated successfully up to 800 interruptions per second for taking moving pictures of the phenomena studied. In taking such pictures an image of the drop was focused on a vertical slot in the center of a long board placed about 2 meters from the object. A photographic film was placed in a slide on the far side of this board, and this slide, propelled by strong rubber bands, was shot past the opening in the board at a speed that carried it a distance equal to the width of the opening in the time between two interruptions. For these pictures transmitted light and the magnesium electrodes were used exclusively.

3. Some of the photographs which were taken are reproduced in Plate I. The magnification is not the same for all of the pictures but it can be estimated in each case from the diameter of the glass tube which was 0.92 mm. throughout. The liquid used was alcohol except for the case represented by Fig. 7. No luminosity accompanied any of the phenomena shown so that the so-called point discharge was not present and all transfer of electricity from the charged surface was effected by means of droplets of liquid and none by gaseous ions.

Two series of pictures taken in the manner described in § 2 are shown in Figs. 1 and 2, the time interval between the separate exposures being approximately one eight-hundredth of a second. The pictures are to be followed from right to left as the downward motion of the flying drops indicates. The doubling of some of the pictures is due to irregularity in the action of the illuminating spark. In the experiment represented by Fig. 1, the alcohol was charged to 5,000 volts and the liquid in the reservoir was 3 cm. above the end of the glass tube, while for Fig. 2 the corresponding numbers were 6,000 volts and 4 cms.

4. A few general statements may help to make clear what is going on in these pictures. Suppose the liquid unelectrified and the supply reservoir raised until liquid issues from the end of the tube at a certain slow rate. Drops with a diameter larger than that of the tube will form, break off and fall away. On electrifying the liquid sufficiently and lowering the reservoir to keep the outflow of liquid the same as before, the drops will be drawn out into more or less cylindrical form before they break from the tube. After severance these cylindrical pieces will coalesce into drops whose diameter may be considerably smaller than that of the glass tube from which they came.

When however the electrification is increased to a point where the electric force at the surface of the liquid attains a certain limiting value, which depends upon the surface tension of the liquid and the radius of curvature of its surface, then, irrespective of whether or not the liquid pressure is sufficient to force liquid out of the tube, the surface becomes unstable and any slight accidental displacement of the surface results in a rapid increase of that displacement. This condition is first reached at the lower end of the drop where the electric density is greatest. What happens is that the liquid at this place is pulled out into a fine thread, which eventually breaks up into minute drops.

5. Returning now to Figs. 1 and 2, it will be seen that very fine points of liquid appear on some of the drops at the end of the tube and also on some of the detached masses. These are the places where there is surface instability, although the fine threads of liquid spoken of can hardly be made out and the myriads of small droplets forming from them are quite invisible.

The fact that instability is confined to but one very small area of the surface is to be explained by the redistribution of electric charge caused by the liquid drawn out from the first place that breaks down. It is possible, however, by increasing the voltage of the surface to have a number of these places of instability existing at the same time on a surface of the dimensions used in these experiments.

As already explained the emission of the large drops seen in the figures is not an accompaniment of surface instability but is conditioned by the excessive pressure of the liquid in the tube. This pressure may be removed by lowering the supply reservoir and then the surface of the drop on the tube appears quite stationary with one or more of the fine points of liquid coming quite abruptly out of the surface where instability obtains. It is noted that the elongated detached masses of liquid retain the instability points for a short time only after they are separated from the tube above. The numerous droplets formed at the points soon carry away enough electric charge to reduce the surface to stable conditions, after which each mass of liquid quickly collapses into a spherical drop. The rapidity with which this collapse takes place is well illustrated by the first two pictures on the left in Fig. 1. In the second picture the elongated cylinder still carries the pointed end while in the first picture, only one c' 'st-hundredth of a second later, the whole has collapsed into a nearly spherical form.

The shielding effect of the drops explains a common behavior illustrated by the pictures in Fig. 1, where it is seen that the drops fly alternately to one side and the other side of the vertical.

The electric force acting on some of the fine threads of liquid often undergoes very rapid changes in direction on account of the drops of liquid in front. Thus in the lower part of the sixth picture in Fig. 2 the fine thread appears as a large double loop, owing to the shielding effect of a drop just off the picture. Smaller but more complex loops are seen in some of the other pictures as for example in the third picture of Fig. 1. Again, the two successive pictures of Fig. 8 show a complete reversal of field. Fig. 3 shows a case where the liquid was torn into shreds by forces varying rapidly in direction. A number of the pieces are barely visible, being out of focus. The appearance at the end of the cylinder in Fig. 4 is that of clouds of finely divided material.

6. Under certain conditions of potential and hydrostatic pressure it is possible to get the alcohol drop at the end of the tube to assume the form of a cone with a fine thread of liquid coming from its apex. This condition is quite steady and is especially suited for a closer study of the liquid thread, which characterizes the state of instability, as well as of the droplets into which the thread disintegrates. The general appearance of this stage is shown in Fig. 5 which represents a picture taken after an exposure of 30 seconds with light concentrated upon the object from an arc lamp placed at the side. The potential of the drop was 5,000 volts.

The thread or stem of liquid coming from the apex of the cone actually had a much smaller diameter than the picture shows since it was not perfectly stationary during the exposure. Measurements of the thread with a microscope showed its diameter to be approximately 0.004 mm. Combining this value with a measurement of the rate of emission of the liquid it was found that the thread was pulled out at the rate of about 8 meters per second. The liquid thread remains intact for but a short distance in this case, breaking up into drops rather suddenly at the place where the enlargement shows in the picture. This enlargement is not apparent however in eye observations with a microscope, the drops flaring out gradually from the solid stem.

The spreading of the drops formed from the central thread of liquid into a more or less conical volume is most probably due to the combined action of the divergence in the electric field and of the mutual repulsion of the drops. No evidence has been obtained of any still finer threads coming from the end of the thread visible in the picture.

The line of demarcation seen in the brushlike cloud of drops shows these to be of two different sets. The outside portion is presumably made up of the set of comparatively small drops which form between the main drops whenever any liquid jet breaks up into drops. None of

the individual drops could be seen in flight with a microscope in instantaneous light, but high powers could not be used owing to their short working distances. Rapid evaporation doubtless made futile the attempts which were made to observe them after catching them on some solid surface. The measurements given above show that even if a length of thread equal to twice its diameter went into the making of each drop, the number of these drops formed per second would be a million.

It may be remarked that the brush spray appears colored both by transmitted light and by reflected light, the colors persisting in each case when the eye is within about 45° of the direction of the light. The colors depend not only on this angle of sight but differ also for the different portion of the brush, indicating thus a difference between the sizes of the drops at these parts.

It should be added that when the condition represented by Figs. 1 and 2 is viewed in continuous light it too has the appearance of a more or less compact brush, like that in Fig. 5, although the outline is not so sharp and the appearance is somewhat granular.

7. On reducing the hydrostatic pressure below the value which was requisite for maintaining the single central spray shown in Fig. 5, the cone of liquid flattens into a drop and the thread of liquid now issues from the side of this drop. Under these conditions of pressure it is possible by increasing the voltage to obtain two points of instability on the surface where two jets of liquid with their sprays of drops come from the surface, as shown in Fig. 6, which is again a time exposure by side illumination. By increasing the voltage still further eight or more such stationary jets may be obtained at the same time, the jets being all arranged on the outer edge of the drop.

8. Glycerine was used in some of the experiments because its viscosity is so much greater than that of alcohol. When the conditions were arranged for a single thread coming from a steady surface it was found that the thread was pulled out in this case a distance of 15 mm. before it underwent disintegration into drops. The set of large drops flared out in their flight into a fan similar to that obtained with alcohol (Fig. 5) but the small drops all shot out from one place in directions at right angles to the axis of the thread and the sharp outer boundary of their paths formed a paraboloid of revolution about this axis. The phenomenon was not sufficiently stationary to permit a successful time exposure to be taken by reflected light, but Fig. 7 shows a picture taken with a 2.5 seconds' exposure by transmitted light of a part of the thread coming from the drop of glycerine. The potential used was 7,000 volts. The diameter of this thread was approximately 0.007 mm. and the speed with

which it was pulled from the drop was about 3 meters per second. The diameter of the drops was found by catching them in various ways and measuring them under a microscope. The large drops in the central brush differed considerably in size but had an average diameter of about 0.01 mm., and the diameter of the small ones in the outer flare was approximately one quarter of this value.

The long known experiment of threads being pulled from highly electrified molten sealing wax is doubtless an example of the action described in this paper.

I am greatly indebted to the skill of my assistant, Mr. W. B. Lang, for the success of the pictures.

SLOANE LABORATORY,
YALE UNIVERSITY.

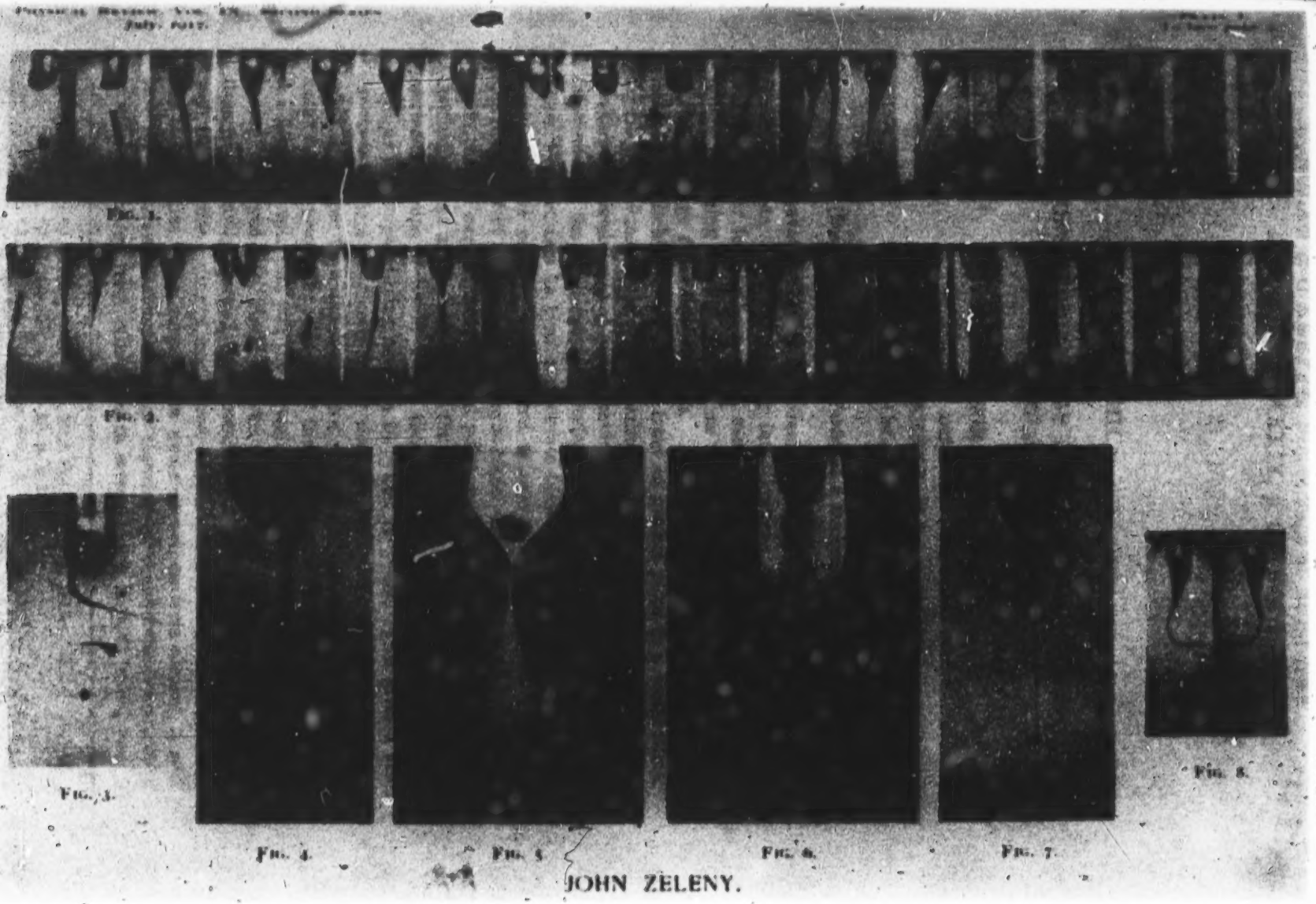


FIG. 1.

FIG. 2.

FIG. 3.

FIG. 4.

FIG. 5.

FIG. 6.

FIG. 7.

FIG. 8.

JOHN ZELENY.

Academy, Vol. XXXIX, p. 21 (1929).

III.

THE IONS PRODUCED BY DISCHARGES AT LIQUID SURFACES.

By PROFESSOR J. J. NOLAN

AND

J. G. O'KEEFFE, M.Sc.,

University College, Dublin.

[Read 11 November. Published 9 December, 1929.]

While there have been many investigations of the phenomena of discharge at metal points, no corresponding investigations of discharge at liquid surfaces appear to have been made, except those of Zeleny. In a series of papers, beginning in 1914, Zeleny has worked out the main characteristics of the discharge from liquid points. Amongst other things, he observed[1] that when a discharge was passing from an alcohol point to a metal plate, the plate gradually received a coating of alcohol. Photographs of the discharge[2] showed drops of liquid leaving the point. Zeleny conceived that the current in the discharge was carried by the liquid in the form of small drops. To test this he blew a moderate blast of air across the gap, and found that the current was reduced to zero, although the blast had no appreciable effect on the discharging surface. He noted that under similar conditions the current from a metal point would not be seriously affected. Concluding that all the current in the discharge from the liquid point is carried by drops of liquid larger than ordinary ions, he computed the radii of the drops as lying between 10^{-4} and 10^{-5} cm. This gives a size for these carriers not merely larger than the ordinary small ions, but considerably larger than the large ions, for which the computed radius[3] is about 4×10^{-6} cm. The mobility of the large ions is about 0·00033 cm./sec. in a field of 1 volt/cm., and the carriers of the liquid discharge, considered as singly charged ions, would be even more sluggish. Even if we imagine them to be heavily charged, their mobility will still be small in comparison with that of the ordinary small ions. If Zeleny's conclusion is correct, and if it applies to discharges from water as well as from alcohol, it will have an important bearing on those theories[4] of thunderstorm electricity in which discharge from rain-drops in intense fields is postulated.

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[1] J. Zeleny, Proc. Camb. Phil. Soc., 18, p. 71, 1915.
[2] J. Zeleny, Phys. Rev., 10, p. 1, 1917.
[3] J. J. Nolan, Proc. Roy. Soc., A, 94, p. 112, 1917.
[4] C. T. R. Wilson, Journ. Frank. Inst., 208, p. 1, July, 1929.

PLAINTIFF'S EXHIBIT NNNNN.

Binks Manufacturing Company
3114 Carroll Avenue
Chicago 12, Ill.

November 5, 1956

Mr. Burke B. Roche
Expenditures on Electrostatic Project.

Dear Mr. Roche:

As you requested, I am listing below the complete expenditures that have been made so far on electrostatic development:

Expenses (Salary & Material) incurred at Binks Manufacturing Company, May 1951 thru 1955		$ 6,201.49
Midwest Research Institute		
1st Contract, March 1953 thru July 1953	$ 7,967.90	
Three Month Extension of 1st Contract, August 1953 thru October 1953	5,762.99	
2nd Contract; November 1953 thru April, 1954	12,573.88	
Ninety Day Extension, July 1954 thru October 1954	1,687.07	
Total		27,991.84
Patent Search and Applications		
Docket 5303, Patent Search	$ 115.00	
Docket 5305, Patent Application, Wire Emitter—United States	291.00	
Canada	162.60	
Docket 5306, Patent Application, Slot Emitter—United States	268.00	
Canada	184.50	
Total		1,021.10

Development Project 108		
Work done in testing for Ford Motor Quotations		
Purchased material	$ 4.00	
Fabrication labor	64.24	
Development & Engineering	800.00	
Total		$ 868.84
Development Project 111		
Electrostatic Development—General		
Purchase material	108.49	
Fabrication Labor	84.10	
Engineering & Development	1,486.00	
Total to date 9/30/56		1,678.59
Power Pact purchased from Ashdee Products Company		5,250.00
Equipment manufactured by Binks which was used by Midwest Research Institute during work for Binks and then presented to Midwest Research Institute as a gift upon completion of the project—Binks' cost		867.14
Total to Date		$43,279.00

Of course, the above figure does not include Mr. Gustafson's time or my time nor does it include any travel expenses which were considerable taking into account the trips to Midwest Research Institute in Kansas City as well as Detroit.

Very truly yours,

John W. Baur

PLAINTIFF'S EXHIBIT QQQQQ

Midwest Research Institute
Engineering Division
16 July 1953

Proposal
R-230

Prepared For
Binks Manufacturing Company
3114-40 Carroll Avenue
Chicago, Illinois

Design of an Industrial Electrostatic Coating System
Midwest Research Institute
Engineering Division

Proposal
R-230

Design of an Industrial Electrostatic Coating System

1. Introduction

The Institute is nearing completion of a research program for the Binks Manufacturing Company having as its general objective the evolvement of a new industrial painting method. The research program, essentially exploratory in nature, was begun with an initial study phase in which current industrial coating methods were reviewed by means of examining patent and commercial literature and by a visit to a factory installation of an electrostatic spraying system. The program rapidly progressed to an experimental basis during which an evaluation by test of several methods of emitting and transporting paint was begun; this evaluation is still underway at the present time.

The paint emitters studies to date have been.

a. Air duct
b. Hollow needle
c. Slotted wedge

These methods were handled in the above order; the first, being particularly unsuccessful, was an attempt to form a paint film on the interior of an air duct and then atomize it off the sharp exit edge of the duct electrostatically. The hollow needle method is quite successful in the process of atomizing the paint which is extruded through the center of the needle; but the needle size which atomizes most efficiently is somewhat limited in its maximum paint flow.

The third scheme, which is currently being evaluated, essentially consists of a slotted wedge from which paint is extruded under air pressure. A rough equivalence to placing many needles side by side is obtained. This device produces a uniform finely atomized pattern at considerably higher rates than a group of needles having the same array dimension as the length of the slot. The slotted wedge emitter is sufficiently promising as the core of an eventual industrial spraying system that it forms the primary basis for the following proposal.

II. Proposal

It is proposed that the Institute extend the general developmental program, related to industrial spraying systems and methods, leading to the objectives outlined below; the boundaries of the investigation and the estimated required appropriation to be as described in the Objectives and Budget Sections, respectively.

III. Objectives

The preliminary success experienced with a slotted wedge paint emitter leads to a definite future objective of this proposed extension: The development of a prototype industrial coating system suitable for lacquer or varnish spraying of flat or large radius surfaces, using the slotted wedge emitter as the basic component of an overall system design. The term slotted wedge emitter encompasses the device as is now being tested and all future improvements or modifications having the same general design feature.

The detailed objectives related to this prototype system development are:

A. A determination of the proper value or range of values of the following variables that will produce a high quality coat:

1. Viscosity
2. Field Strength
3. Drying Retarders
4. Transport Distance
5. Emitter Critical Dimensions
6. Material Pressure
7. Flow Rate

B. A mechanical design of a flexible coating system, easily adjustable for a wide variety of work shapes and sizes. This design shall be made with an attempt to simplify the component parts as much as possible in order to keep manufacturing costs to a minimum.

C. Evaluation under test of the performance of the entire system when coating various work shapes.

A secondary, but major category of the proposed work is exploratory in nature. The development of a workable coating system as described above are of prime importance, but it is felt that investigations should be continued along

other lines as well. The need for paint emitters that will satisfactorily coat materials of shapes other than sheets or large radius curves is evident and forms the basis of the objective for this secondary proposed phase. This objective is the development of other types of paint emitters than the slotted wedge suitable for special work shapes such as interior surfaces and cavities.

IV. Discussion

The proposed program is a formulation of two general goals; one, the development of a workable coating system that can be production engineered to a potentially marketable item and the second, essentially an extension of the present program in an exploratory sense.

It is felt that the coating performance of the slotted wedge is such that it is quite probable that an efficient, flexible coating system can be devised. A two-inch long, 0.001 in. wide slot assembly has been tested to date which produces a finely atomized spray at low air pressures resulting in a high-gloss coat. Depending upon the emitter-to-work distance the coating pattern can vary from roughly circular to elliptical in shape. It is intended to stack these slotted emitters on a common axis, producing an extension of the individual slot patterns along one line. This type of array can be repeated in sufficient numbers to meet the required paint flow rates, although a single stack may be sufficient for some work. It is, of course, possible to curve the stack axis so as to conform to general curvatures of particular production items being coated.

Experience obtained so far on the slot emitter does not indicate any clogging difficulty, however, the system will be operated on an intermittent basis to determine the problems in this respect.

Electrostatic coating of pieces having cavities or sharp

internal radii is known to be extremely difficult and has been by-passed by coating the part in general electrostatically and then touching up the inaccessible regions with a conventional hand spray gun. Industrial coating systems in which an air spray gun is rapidly reciprocated across the work dimension have been most successful in this respect. Electrostatic coating of cavities will have to be handled by special techniques.

The hollow needle emitter or a variant on it could be adapted, for instance, to the problem of painting the interior surfaces of egg-crate fluorescent light diffusers. There would be a requirement for rapid handling of this diffuser in placing it in proper position with respect to a special emitter containing a needle for each cavity of the diffuser. The voltage requirement for this operation would be relatively low, and the cost of the emitter would not be high. The above seems as a good example of a special requirement for a paint emitter.

The case of air flow to augment electrostatic field effects is still being considered and may prove helpful in coating materials having cavities.

IV. Budget

The total cost of the proposed project will be determined by the time directly devoted to this work by members of our professional staff, plus out-of-pocket expenditures for supplies and incidental expenses as required to accomplish the stated project objectives.

Based on the Institute's experience in forecasting research and development costs, it is estimated that the cost of the project will be:

Staff Services	$14,350
Supplies, Travel, Misc.	650
Total Estimated Cost	$15,000

The Institute will extend all possible effort to accomplish the stated objectives within this estimate. Under no circumstances will it expend more than this sum without prior consultation with, and approval by, the sponsor.

If the project is completed in a shorter time, with less expenditure than estimated above, or if at any time during the course of the project it should be mutually agreed to conclude the work because of technical or policy decisions, the sponsor will be charged only for the expenditures actually incurred as of the date of termination.

Midwest Research Institute
P. D. Wickersham,
Project Engineer.

Approved by:

F. N. Stephens, *Manager,*
Engineering Division.

PLAINTIFF'S EXHIBIT RRRRR.

Midwest Research Institute
Engineering Division

Progress Report No. 1

May 15, 1953

Binks Manufacturing Company

Project No. 971-E-433.

A Study of The Application of Dynamic and Electrostatic Techniques to Paint Spraying Systems.

I. Introduction.

The subject program is concerned with the development of new and better means of applying paint to variously shaped objects to form the basis for an industrial painting process. The project has been established on an initial study phase which comprises a literature search and an associated experimental program. Currently employed electrocoating techniques in the industry are to be studied with an eye towards evolving basic methods or alterations, resulting in an improved process. The general method of electrocoating is to form a major part of the work, but is to be augmented by a study of airflow and ultrasonic techniques.

The objective of this study is the recommendation of a method to be employed in the design of a prototype coating system.

II. Project Activity Summary.

A. Literature Survey

To date, the major portion of the work that has been carried out in connection with this project has consisted of a survey of a number of United States Patents furnished by the project sponsor. This study involved the separation of those patents directly or indirectly pertaining to a coating processes from the irrelevant ones in the group, and a subsequent review and abstracting of information contained in these selected patents. This search has been most useful in supplying project personel with much needed background material. A summary of the highlights of this study is presented below.

The patent search covered over 200 patents. Some 87 of these were found to apply directly or indirectly to the problem of depositing coating materials on articles or materials. These 87 patents indicate that the technique of using electric fields in the application of coatings is a long-established art. As early as February, 1924, an application for patent was filed on "an invention relating to articles of manufacture consisting of a support and a layer of comminuted material deposited thereon; and more particularly to producing and maintaining the physical union of the material and the support," which employed electric fields for the purpose of depositing the comminuted material on the supporting material.

A little over four years later, in December, 1928, the Western Electric Company, Inc., filed an application for patent of "an invention relating to methods and apparatus for finishing metal parts." This patent covers a direct application of the electrostatic method of paint spraying inasmuch as it states that "in order to accomplish the uniform deposition of coating material, this invention contemplates the conveying of metal parts or other articles

to be coated through a closed chamber, the parts being connected to one terminal of a source of high potential electric energy. The opposite terminal of this source is connected to a nozzle through which an atomized spray of coating material is introduced into the chamber, thus giving the particle of coating material in the atmosphere of the chamber a charge opposite to that of the article to be coated." The patent farther states that, "to prevent undue coating of the inside of the chamber, the walls are connected electrically to the same source of potential as is the nozzle."

An improvement over this electrostatic spraying method was realized in a patent assigned to the Research Corporation of New York, New York, application for which was filed in March, 1934. According to the specifications of this patent it was found that it is possible to cause deposition of coating material in pattern form by "controlling the electric field distribution through electrode shaping."

A variation on the coating method was covered by a patent filed in February, 1935, and subsequently assigned to the Raymakers Syndicate, Ltd., of London, England. This patent covers an electrostatic coating method and apparatus which contemplates applying the coating material by rotation or dipping and then smoothing the finish and removing the excess coating material by subjecting the coated article to the effects of intense "electric and magnetic fields"; a detearing operation.

In addition to these patents dealing directly with the application of paint to various articles and materials, several others were issued up to the year 1941 which cover electrostatic methods of depositing abrasive materials, flocking, and even liquids such as glue, to sheets or webs and other articles and materials.

In July, 1941, a patent on an invention by Harold P. Ransburg and Harry J. Green was issued and assigned to the Harper J. Ransburg Company (later to become the Ransburg Electro-Coating Corporation) of Indianapolis, Indiana. From all of the information contained in this United States Letters Patent No. 2,247,963, the system that was proposed is in many respects identical with the one covered by the Western Electric Company patent of 1928. The major difference lies in the fact that the Ransburg System employs the use of non-conducting walls in the spray booth.

Between the years 1941 and 1951 the Ransburg Electro-Coating Corporation was assigned some 27 of the 62 patents which were included in the group that was studied. Most of these pertained directly to the original spray coating system but some few covered auxiliary items as conveyor systems, over-spray recovery, control of electrostatic fields (*i.e.*, spark preventing apparatus) and even special processes for electrocoating granular materials. Many of the patents in this group, not assigned to the Ransburg Corporation, deal with electrodeposition of granular abrasive materials and flocking materials but some apply also to electrostatic painting and even printing processes.

The over-all picture presented by the study of these patents shows that the patents which have been issued pertain to specific apparatus, *i.e.*, design patents, and that the process of electrocoating, being a fundamental one, cannot be claimed exclusively by any one individual or firm. At this stage the design patents do not appear to be overly restrictive as to their effects on the formulation of different systems.

PLAINTIFF'S EXHIBIT XXXXX

Miller Brothers Co.

4220 Ocean Park Ave. - EXbrook 8-5776 - Venice, California

Date: October 17, 1956

Subject: Ajax Hardware

To: Ransburg Electro-Coating Corp.

Attention: Dr. Emery P. Miller

From: Herman E. Miller

Dear Emery:

You should be receiving in a few days, signed agreements from the subject company, together with their purchase order. You will note that they have added an amendment to the agreement which was intended to substitute for a guarantee from you that the equipment would coat their parts satisfactorily. I explained to them that such a guarantee was impossible and that the best we could do would be to state that the equipment would do the same kind of a job for them as it is doing for American Cabinet Hardware and others. I trust you will find this amendment acceptable. If not, we may be able to jockey it about a bit to suit you.

Very truly yours,

Miller Brothers Co.

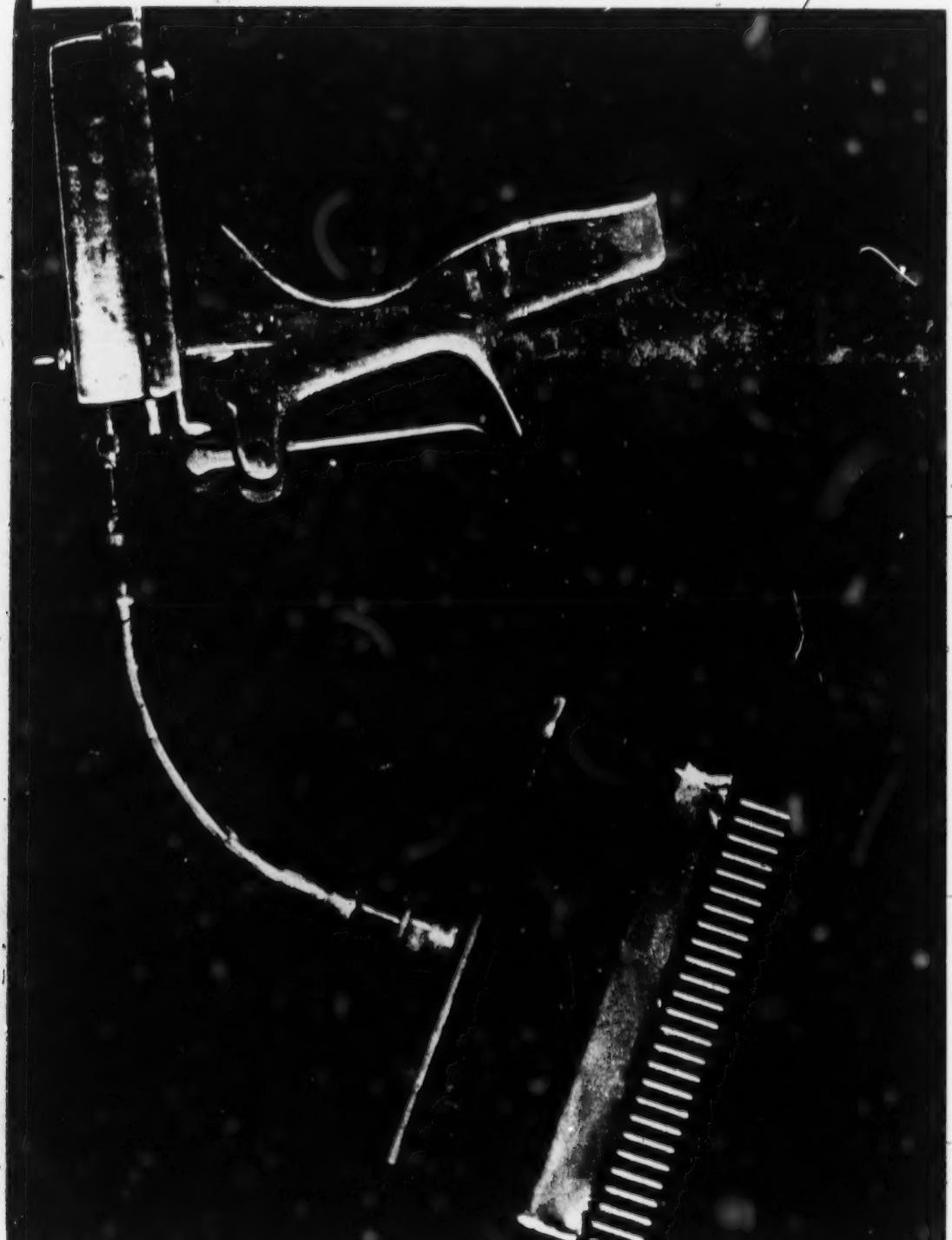
Henry

Herman E. Miller

HEM:jl

Air Mail

DEFENDANT'S EXHIBIT NO. 10-A



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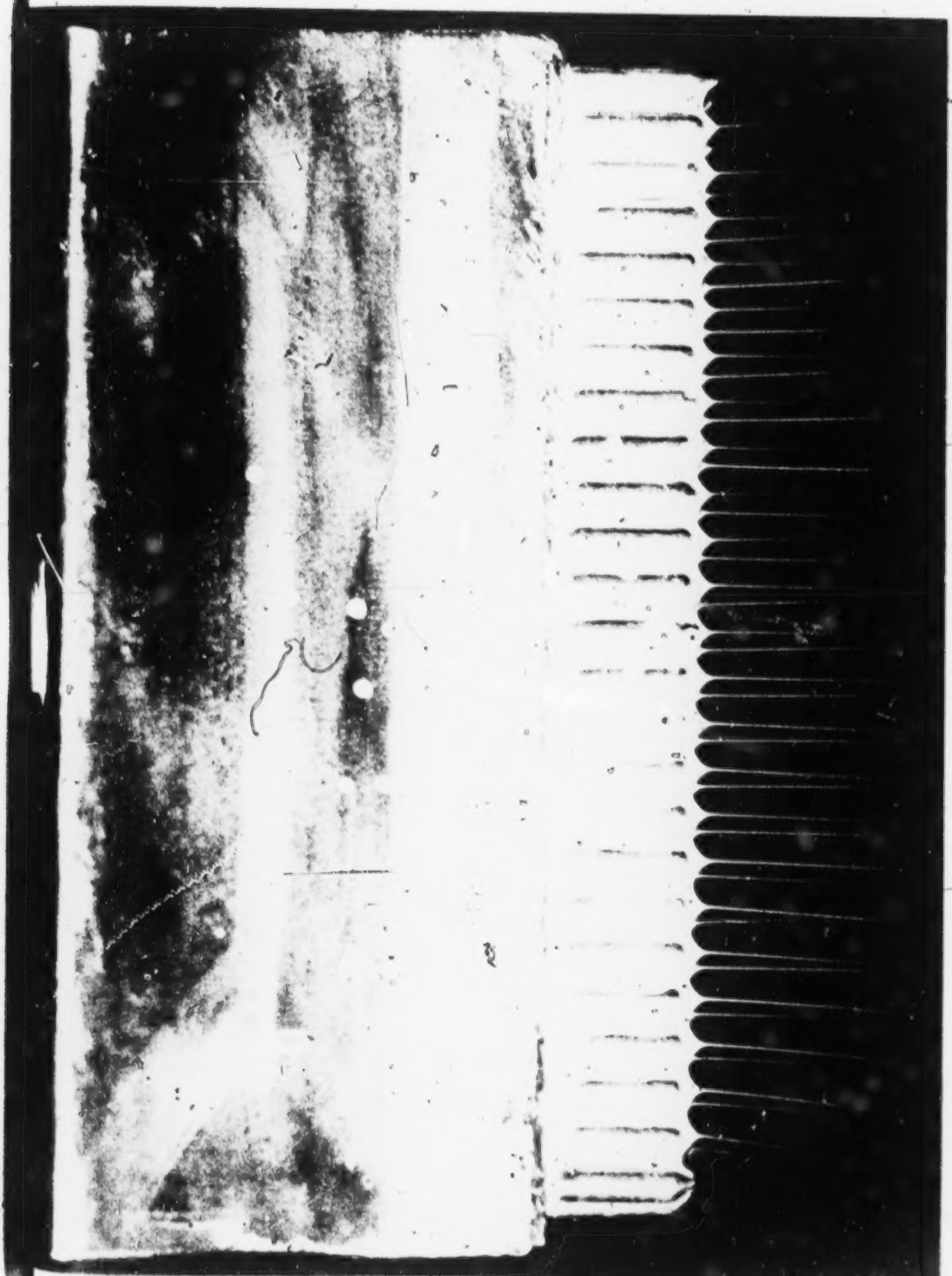
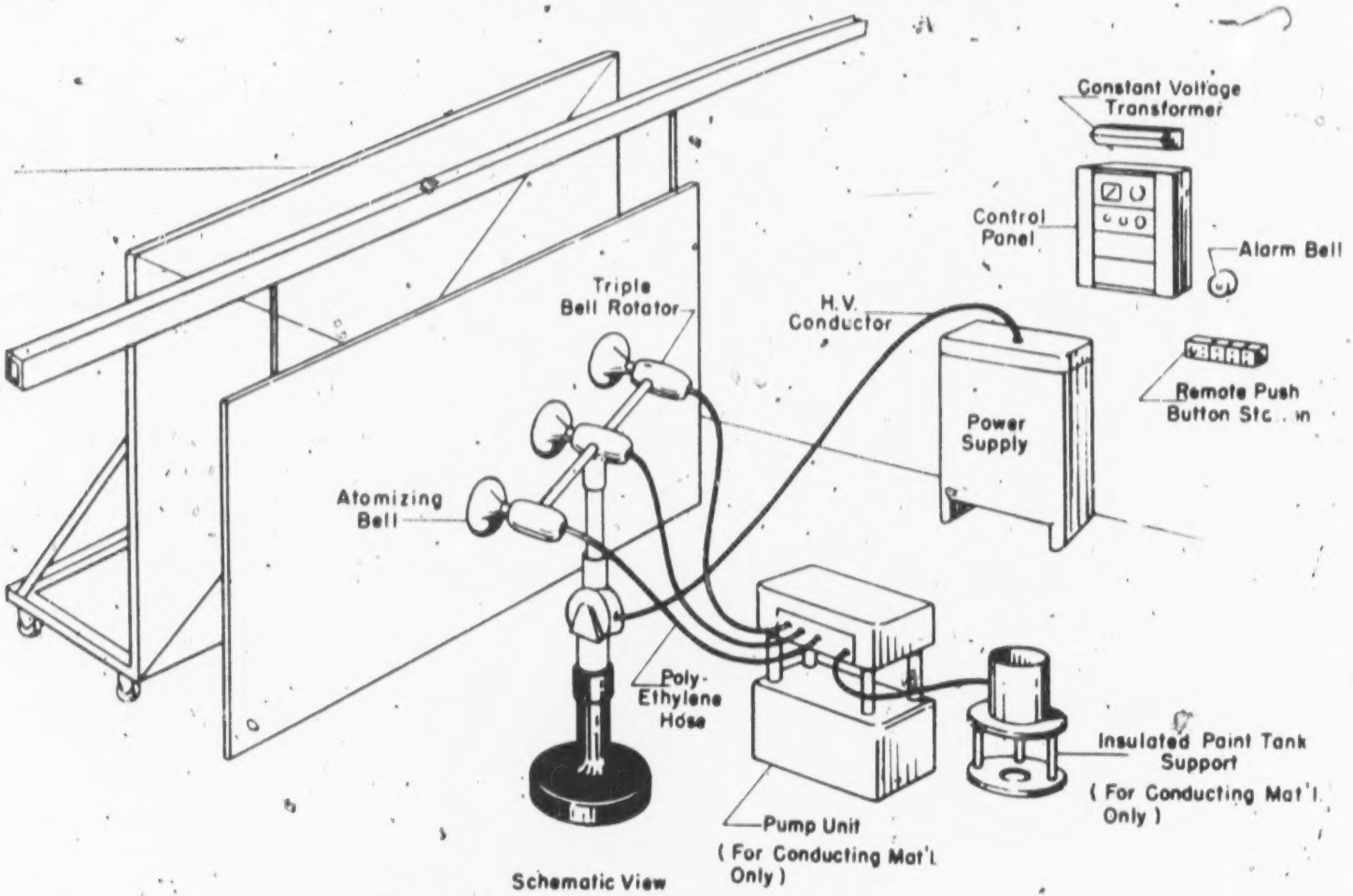


TRIPLE HEAD ATOMIZING UNIT



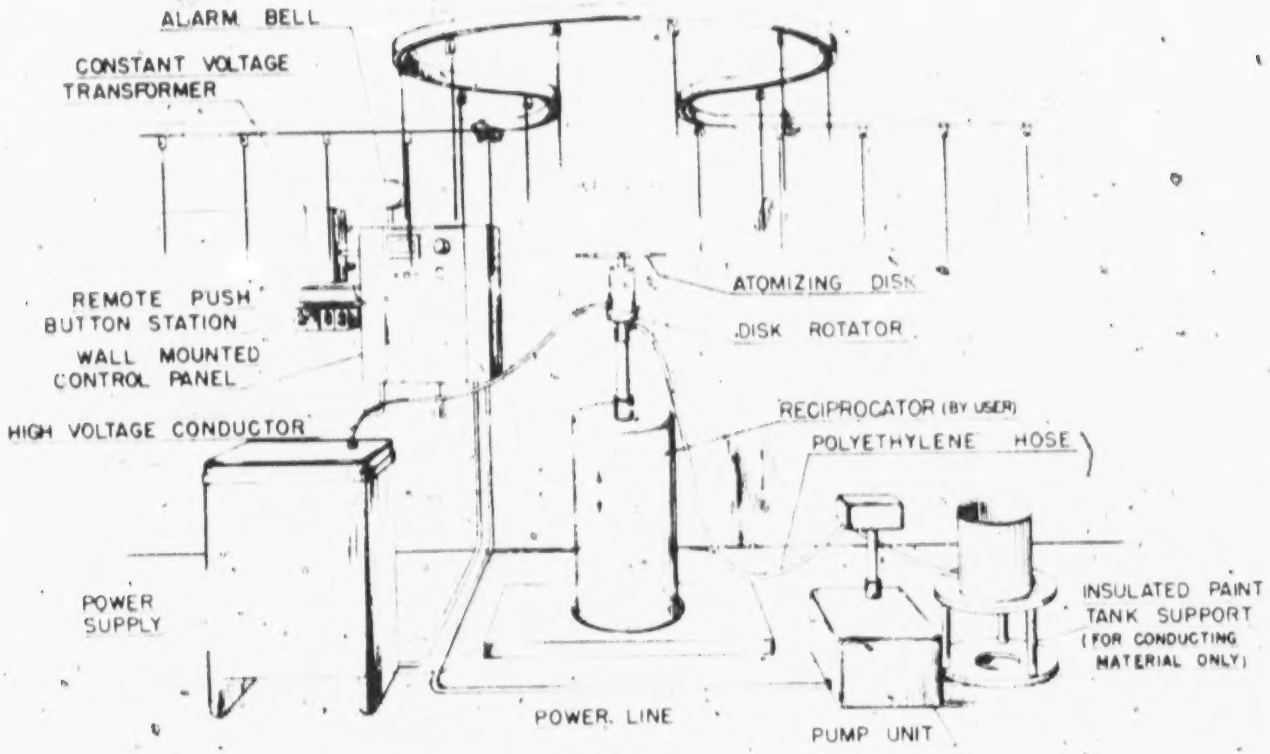
Schematic View

TRIPLE HEAD INSTALLATION
WITH
WALL MOUNTED CONTROLS

DEFENDANT'S EXHIBIT NO. 17-A

DEFENDANT'S EXHIBIT NO. 17-B.

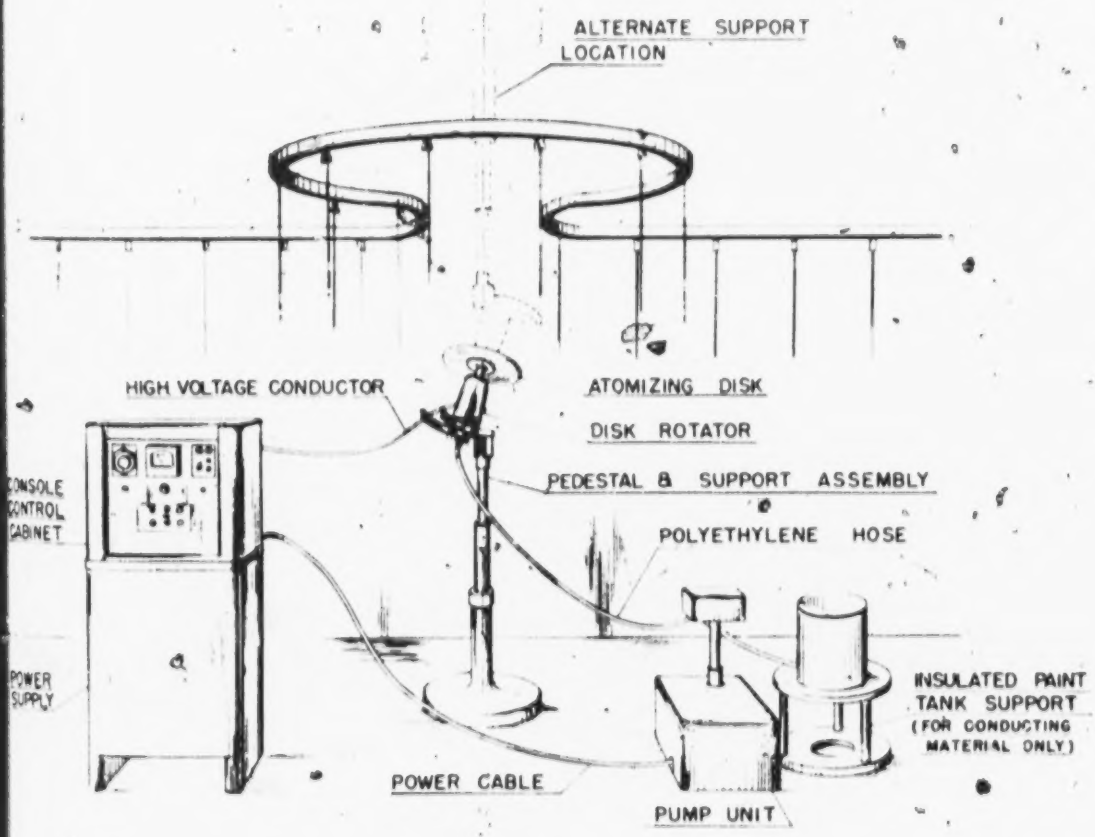
RECIPROCATING DISC ATOMIZING UNIT



SCHEMATIC VIEW
RECIPROCATING DISK INSTALLATION
WITH
WALL MOUNTED CONTROLS

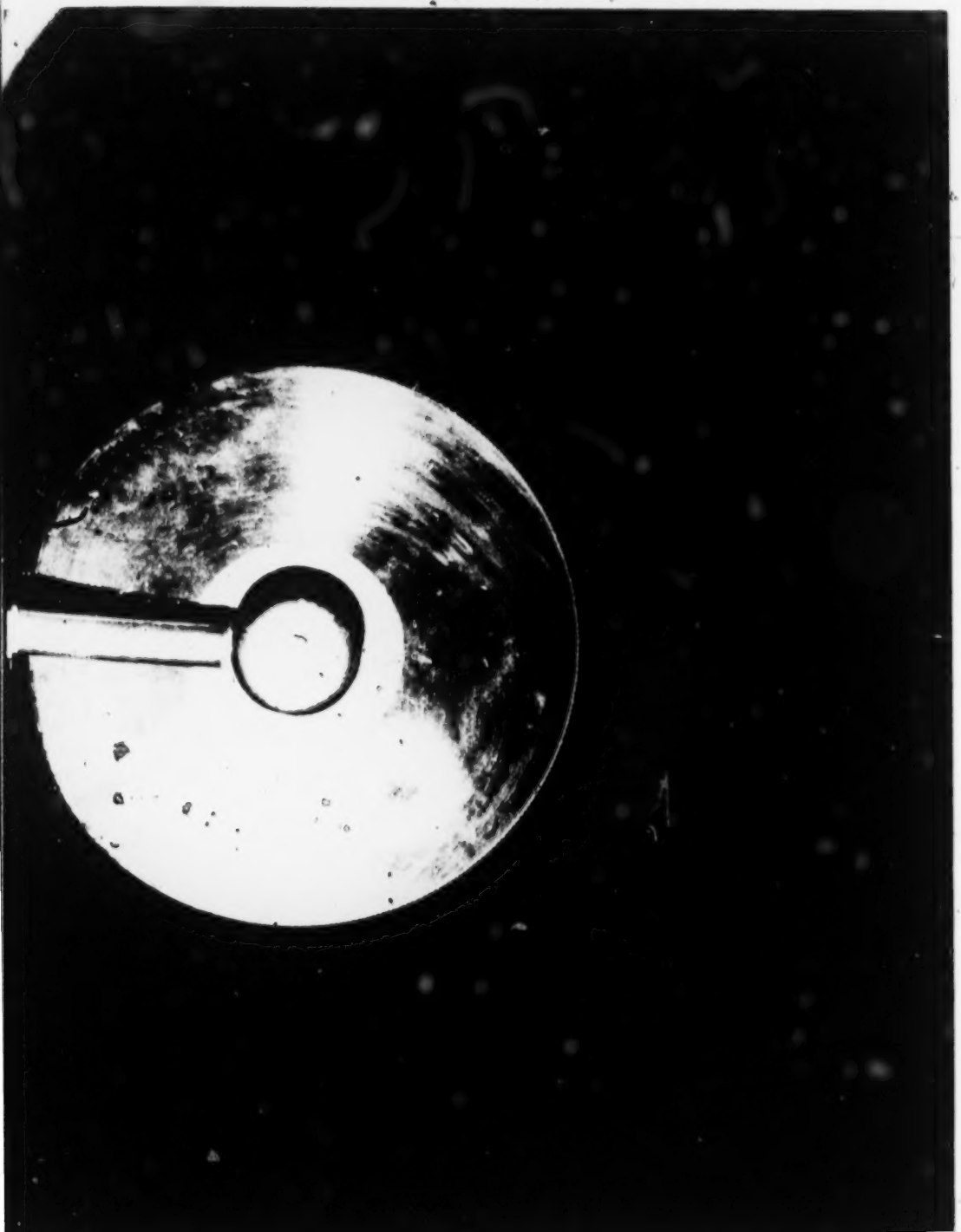
DEFENDANT'S EXHIBIT NO. 17-C. 9651

TILTING DISC ATOMIZING UNIT



SCHEMATIC VIEW
TILTING DISK INSTALLATION
WITH
CONSOLE TYPE CONTROLS

DEFENDANT'S EXHIBIT NO 18-A



DEFENDANT'S EXHIBIT NO 18 B

DEFENDANT'S EXHIBIT No. 41

October 1, 1958

Avco Manufacturing Corp.
1329 Arrington Street
Cincinnati, Ohio

Attention: Mr. A. D. Redfield, Patent Counsel

Dear Mr. Redfield:

It has recently come to our attention that the first "Whereas" clause in our Agreement No. 5228 with your company for use of our No. 2 Process in the coating of automatic washing machine equipment, as set forth in our letter of January 18, 1954, contains an inadvertent error.

As you will recall, in the conference which preceded the execution of this agreement, you requested that we list in schedules to an amendment of our printed form agreement, as was done in response to your request, to our earlier Agreement Nos. 3463 and 3464 for your use of our No. 1 Process at your Richmond, Indiana plant, all patents and patent rights mentioned in a general way in our discussion including all of those listed for your earlier Agreement Nos. 3463 and 3464 which were existent at the time, whether or not they related in any manner to your use of the No. 2 Process.

Inasmuch as Schedules A and B to Agreement No. 5228 were prepared pursuant to such request, we did not represent, and do not now represent, that all of the patents and patent rights referred to therein pertain to the No. 2 Process, and our printed form "Whereas" clause which was inserted in our letter of January 18, 1954, should have been limited accordingly.

We trust that this letter will serve to clarify the matter.

Very truly yours,

HED:bat Harry E. Downer

Avco Manufacturing Corporation
1529 Arlington Street
Cincinnati 25, Ohio

October 7, 1958

Harry E. Downer, Esq.
Ransburg Electro-Coating Corp.
3939 West 56th Street
Indianapolis, Indiana

Dear Harry:

Your letter of October 1 puzzles me. I have a note in my file indicating that I had insisted, probably at our conference on January 6, 1954, that the first "Whereas" clause specify the patents and applications covering the No. 2 process so as to tie down the term "said process" as used in the agreement to what is described and claimed in the patents. Apparently what was done was to include a general list of all patents you owned in Exhibit A, which was not responsive to my request.

You now state that you did not mean to represent that all these patents applied to the No. 2 process. Assuming this is the case, what patents do you have which *do* actually apply to and are limited to the No. 2 process?

I would like to ask another question, namely, is there any sound basis upon which Ransburg can assert that despite the dismissal of the case against Hamilton in Wisconsin Ransburg has been and is taking diligent steps to police the patents, which would justify its licensees in continuing to make payments under their respective license agreements?

Yours very truly,

Alden

Alden D. Redfield,
General Patent Counsel.

ADR:EL

Mr. Alden D. Redfield October 13, 1958
Avco Manufacturing Corporation
1529 Arlington Streets
Cincinnati 25, Ohio

Dear Alden:

This is in answer to your letter of October 7th. It appears that our understandings of our 1954 conference at this time vary in some respects but in view of the time that has transpired since that conference, this is not surprising. The important point is that I wanted to make clear to you that we do not represent that all of the patents and applications referred to in Exhibits A and B to Agreement No. 5228 do pertain to the No. 2 Process.

The more important patents which do apply to your use of our No. 2 Process under Agreement No. 5228 at your Nashville plant are as follows: 2,685,536; 2,794,417; and 2,839,425. Each of these patents were pending as applications in the Patent Office at the time of our letter amendment dated January 18, 1954 of Agreement No. 5228.

Our suit against Hamilton in Wisconsin was based on two patents that related to methods and apparatus for arranging articles in a particular way. Hamilton used the inventions of these patents in coating articles in a compressed air electrostatic spray coating system and not a system in which the paint was atomized electrostatically. Our No. 2 Process was not involved.

We hope your operations in Nashville with our No. 2 Process are going quite satisfactorily. As you may have known at the time we made that installation for you, several of the largest major appliance manufacturers had already installed our No. 2 Process and I am happy to advise that now most of the major appliance industry is using it.

Yours very truly,

HED:so Harry E. Downer.

UNITED STATES DISTRICT COURT.

(Caption—56-C-262)

FINDINGS OF FACT AND CONCLUSIONS OF LAW.

For a number of years prior to the incorporation of defendant on January 1, 1948, its predecessors were engaged in the manufacture and sale of houseware items. In the year 1937, they commenced experiments in using a paint coating materials on its manufactured products. Up to this time, they used the conventional process of compressed-air guns without an electrostatic field. These experiments resulted in the development of what they called their No. 1 Process for which United States Patent Number 2,247,963 was issued. The validity and infringement of this patent is not in issue. The No. 1 Process called for the spraying of coating material by means of compressed-air spray guns into an electrostatic field which was maintained between wires or electrodes and through which field the grounded conveyorized articles of manufacture passed, so that the atomized paint forced into the field by compressed-air became electrically charged and was urged toward deposition upon the articles by the effect of the field. The No. 1 Process, as compared with the prior conventional process of spraying paint coating, substantially reduced over-spray, paint loss and labor expense, and it was a substantial improvement in many commercial applications. This process was marketed in the year 1944 and was the first commercially used electrostatic spray painting system. The conventional equipment items such as conveyors, ovens and spray guns were not supplied by defendant or its predecessors but were purchased by their licensees from the plaintiff and other suppliers.

The defendant's predecessors continued their research

and development work which resulted in the development of what they called their No. 2 Process and an application for patent was filed on September 29, 1944 for which United States Patent Number 2,685,536 was issued on August 3, 1954. The No. 2 Process made it possible for articles to be coated electrostatically without the necessity of compressed-air spray guns to atomize the coating material. In this process, in substance, the electrostatic field is maintained directly between the atomizing device, or head, and the articles on the conveyor. The liquid coating material is fed at a controlled rate to and distributed along the extended edge of a stationary or rotating atomizing head. The strength of the field at the edge is such that the field is capable of electrostatically atomizing fine, electrically-charged particles from the liquid. The field then disperses those particles in the form of a spray, and deposits them upon grounded articles of manufacture situated on a conveyor moving through and a part of the field. The No. 2 Process, as compared with the No. 1 Process and prior conventional processes of spraying paint coating, in many commercial applications, virtually eliminated over-spray, paint loss, further reduced labor costs, substantially reduced the manufacturer user's investment in spray booths, exhaust systems and related equipment.

While the application for the patent was pending the defendant was incorporated, became the owner thereof, and since has been engaged in the business of marketing systems employing electrostatic forces in the automatic application of paint or other liquid coating to articles of manufacture carried by conveyors. The first license of the No. 2 Process was granted by defendant in the year 1949, under a special consulting and research agreement with Enameled Steel and Sign Company of Chicago, Illinois. General marketing of the system was commenced in the year 1951. Thereafter the patent on the No. 2 Proc-

ess issued on August 3, 1954, as United States Letters Patent Number 2,685,536. Inasmuch as the special paint atomizers and accurately controllable paint supply systems required for operation of the No. 2 Process were not available on the market, defendant designed and produced them and furnished them to licensees as part of the specialized equipment.

The plaintiff has been in business since the year 1892, has branch offices or warehouses in twenty-eight (28) major cities in the United States and Canada. It has and is manufacturing and selling spraying equipment for paint and other materials in the Southern District of Indiana. It sells a line of merchandise under the slogan "Everything for Spray Painting," and is one of the two largest merchandisers of spray painting equipment in the United States. It sells, and for many years has sold, a large volume of compressed-air spray guns, for both manual and automatic operation, and in many instances sells complete finishing facilities as a package, including spray guns, spray booths, paint-collecting devices, exhaust systems, and related equipment. In the year 1958, four years after the issuance of defendant's No. 2 Process patent, the plaintiff added to its advertised line of products electostatic spray painting equipment of the compressed-air type as depicted by defendant's No. 1 Process.

The plaintiff's first knowledge of a method for painting by the use of compressed-air and an electrostatic field was attained in the late 1930's or early 1940's from the No. 1 Process of the defendant's predecessors. In December of 1942, at the invitation of the defendant's predecessors, several of plaintiff's representatives attended a demonstration of the No. 1 Process at Indianapolis, Indiana. Plaintiff's first knowledge of an airless electrostatic painting process was obtained from defendant's No. 2 Process, after it was commercialized. In January of 1951, after dis-

cussions of the subject of electrostatic spray painting, the plaintiff purchased a power pack and carried out experiments in that year in keeping with its knowledge of the market development. Plaintiff then engaged in a broad base research to investigate and develop methods of painting other than those being practiced with its products. Its research was sporadic until April 1, 1952, when it hired for that purpose James H. Rice, who began by reviewing all of the patents in the field. In the year 1952, plaintiff negotiated with the co-patentee of the patents in suit and another former research employee of defendant, with the intent to employ them, but no agreement was reached. During the years 1951 and 1952, plaintiff gave consideration to acquiring the business of a third party which was in business of marketing air-type electrostatic spray coating systems in competition with defendant's No. 1 and 2 Processes, but these negotiations terminated. In the year 1953, plaintiff engaged an independent research organization to improve equipment for the application of paint as a coating which was performed in the years 1953 and 1954. The research culminated in the development of an atomizing head, or emitter, called SK661, a drawing of which was made and dated May 12, 1954. The emitter is intended for use in an airless electrostatic coating system which is the subject of the charge of infringement by defendant's counterclaims. After plaintiff learned of the issuance of defendant's No. 2 Process on August 3, 1954, its research ceased. The plaintiff attempted to market for electrostatic spray painting its SK661 emitter and the equipment related thereto to the Ford Motor Company on January 25, 1956. In response to Ford's request plaintiff unsuccessfully quoted its price with this express provision:

> "This bid shall not be binding upon Binks Manufacturing Company as an offer unless and until Ford Motor Company shall indemnify Binks Manufacturing

> Company and hold it free and harmless against any and all suits or cause of action which may be brought against Binks Manufacturing Company for infringement and/or contributory infringement of Starkey et al. patent 2,685,536 by reason of manufacturing and furnishing Ford Motor Company the devices comprising the subject matter of said bid or by use by Ford Motor Company of said devices."

Thereafter in an exchange of correspondence consisting of eight letters commencing on July 3, 1956, and ending on September 21, 1956, the plaintiff stated it was ready to market a paint sprayer which electrostatically atomized paint without making use of compressed-air spray gun and requested defendant send its standard license form. When defendant sent its No. 2 Process license form without equipment and the alternate license form with equipment, plaintiff sent defendant a print of its SK661 drawing of May 12, 1954, stating that neither form of license was satisfactory, that it was interested in a "license to make and sell equipment for this type of spray painting" under the defendant's No. 2 Process patent; that the license without equipment form was not acceptable because it required continuous periodic payments of royalties based on the extent of the coating material used and that plaintiff's sales practice was such that any license agreements would have to require the payment of only one royalty payment at the time of each sale so that, thereafter plaintiff's customer's use of the equipment would be free of any further royalty payments, and requested defendant consider granting such a license based at a given rate of percentage of the sales price. The defendant responded:

> "* * * Granting licenses on this basis would require a complete change in our marketing policy and a change of all of our licenses now in effect, as otherwise a large part of our licensees would be treated unfairly. We also believe that the system you suggest is not sat-

isfactory for determining the proper value for the use of the process.

"In view of the foregoing we trust you can readily understand why we feel that we cannot comply with your request. We want you to know that licenses are available to your customers for painting with our method and we assume you will not furnish the equipment which has been the subject of this correspondence to such customers unless they are licensed by us."

Twenty (20) days after this exchange of correspondence, the plaintiff commenced its action by the filing of its complaint.

The plaintiff's complaint and amendment thereof sought a declaratory judgment that the defendant's No. 2 Process patent issued August 3, 1954 as United States Letters Patent 2,685,536 entitled "Method for Electrostatically Coating Articles," was invalid, and alleged misuse, violations of the anti-trust law and unfair competition by defendant. Upon the filing of defendant's counterclaim, the plaintiff filed its cross-counterclaim and voluntarily dismissed its amended complaint since the question of justicable controversy had been rendered moot by the defendant's counterclaim which was in the form of a conventional patent infringement action. Thereafter, and while the action was pending, on June 4, 1957, United States Letters Patent 2,794,417 issued to the defendant, and was entitled "Apparatus for Electrostatically Coating Articles." The apparatus patent applied for on June 4, 1954 upon which the apparatus patent 2,794,417 issued, was a division of the application of September 29, 1944, on which the method patent 2,685,536 issued. The apparatus patent was then also made a subject of the litigation by the defendant's filing of its supplemental counterclaim and plaintiff's filing of its supplemental cross-counterclaim.

The pleadings having been consolidated by substitution the case was tried upon the issues presented by:

Defendant's substituted counterclaim, seeking injunction and damages on account of alleged infringement by plaintiff of defendant's United States Patent 2,685,536 and plaintiff's substituted answer of three defenses, denial of infringement, invalidity of the method patent and misuse of the patent;

Defendant's substituted supplemental counterclaim seeking injunction and damages on account of alleged infringement by plaintiff of defendant's United States Patent 2,794,417 and plaintiff's substituted answer of five defenses, denial of infringement of the apparatus patent, invalidity of the apparatus patent, two defenses of estoppel to assert the apparatus patent, misuse of the apparatus patent; and

Plaintiff's substituted cross-counterclaim, seeking an injunction, threefold damages and an accounting for alleged violation of the anti-trust laws and unfair competition by defendant and defendant's substituted answer of two defenses, denying the alleged violation of the anti-trust laws and unfair competition and pleading the two-year statute of limitations with respect to plaintiff's claim for threefold damages under Section 15, Title 15, U.S.C.

Patent 2,685,536 in suit is directed to methods of electrostatically spray-painting without the use of compressed air. It contains eleven claims, all of which, with the exception of claims seven and nine, are asserted by defendant to have been infringed by plaintiff. Claims one, two and ten have been treated as typical.

Patent 2,794,417 in suit is directed to forms of apparatus for use in practicing the method of the other patent 2,685,536. It contains four claims, but only claim four is relied upon by defendant as having been infringed by plaintiff.

Typical of this class of cases, the issues are multiple and the evidence and briefs are voluminous.

The evidence of both parties consisted of exhibits, rec-

ords, written evidence, admissions, stipulations, interrogatories and depositions. The plaintiff offered no testimony of witnesses in the presence of the Court at the trial. The defendant in addition offered testimony of witnesses in the presence of the Court at the trial who were vigorously cross-examined.

Findings of Fact.

1. Defendant, Ransburg Electro-Coating Corp., is a corporation organized and existing under the laws of the State of Indiana and has its principal offices and place of business at Barth and Sanders Streets, Indianapolis 7, Indiana.

2. The plaintiff, Binks Manufacturing Company, is a corporation organized and existing under the laws of the State of Delaware and has its principal office and place of business at 3114-40 West Carroll Avenue, Chicago 12, Illinois.

3. The action of the defendant arises under the patent laws of the United States, 35 U.S.C., Section 271, 281, et seq.

4. The amount involved in the controversy presented by plaintiff's cross-counterclaim is in excess of Three Thousand ($3,000.00) Dollars, exclusive of interest and costs and its action arises under the anti-trust and anti-monopoly laws of the United States, 15 U.S.C., Section 1, 2, 14 and 15.

Defendant's Development of Electrostatic Spray-Painting Methods and Apparatus.

5. On August 3, 1954, the defendant was issued United States Letters Patent Number 2,685,536, entitled "Method for Electrostatically Coating Articles," on an application for patent filed on September 29, 1944, in the names of William A. Starkey and Edwin M. Ransburg, which patent

is owned by defendant. On June 4, 1957, the defendant was issued United States Letters Patent Number 2,794,417, entitled "Apparatus for Electrostatically Coating Articles" on an application filed June 4, 1954, based upon the aforesaid application filed September 29, 1944, in the names of William A. Starkey and Edwin M. Ransburg, which patent is owned by defendant. The above patents, which relate to the No. 2 Process, are those in suit. The application of June 4, 1954, upon which patent 2,794,417 issued, was a division of the application of September 29, 1944, on which patent 2,685,536 issued.

6. The defendant, since its incorporation on January 1, 1948, has been engaged in the business of marketing systems employing electrostatic forces in the automatic application of paint or other liquid coating to articles of manufacture carried by conveyors. The two coating systems which it markets are:

(a) The "No. 1 Process," first developed, in which paint sprayed from essentially conventional compressed air spray guns is electrostatically deposited on the articles; and

(b) The "No. 2 Process," later developed, in which paint atomized under the influence of electrostatic forces without the use of compressed air is electrostatically deposited on the article.

In addition to its coating systems, defendant markets a "detearing" system, in which electrostatic forces are used to remove the "tears" of excess paint which accumulate on the lower edges of articles previously coated by dipping or flow-coating.

7. Defendant's present business had its origin in an individual proprietorship, operated by Harper J. Ransburg, a resident of Indianapolis, Indiana, who was engaged in the manufacture and sale of a variety of housewares items, such as canister sets, bread boxes and similar

accessories. He was assisted in this business by his three sons, Gegg, Harold and Edwin, and in 1941 they formed a partnership, the Harper J. Ransburg Co., which continued to make and sell housewares, but which also commenced the marketing of the detearing process and the No. 1 Process. As of January 1, 1948, with the incorporation of the defendant, the two businesses were separated, the defendant corporation taking over the business of marketing the coating and detearing systems. Defendant is owned by the four Ransburgs, who are its officers and directors.

8. Prior to the development of the Ransburg No. 1 Process, defendant's predecessor had painted many of its products by a widely used system in which a spray of paint formed by and projected from a conventional compressed-air spray gun was directed toward the articles to be painted. Such systems still are widely used in industry. However, when coating is done by means of compressed-air spray guns, much of the material sprayed is not deposited upon the article, but is carried beyond it by the air blast and is lost as "overspray"; and a substantial investment and expense is necessary in installing, maintaining, and operating spray booths, paint collecting devices, and exhaust systems. The Ransburg electrostatic coating systems were devised to reduce the cost of coating by the spray method.

9. Commencing in about 1937 the Ransburgs conducted experiments in using a high-voltage electrostatic field to deposit more efficiently upon articles of manufacture coating material atomized by conventional compressed-air spray guns. As the result of this work, they developed their "No. 1 Process," in which the coating material is sprayed by means of compressed-air spray guns into an electrostatic field which is maintained between wires or electrodes and the conveyorized articles of manufacture, so that the

paint particles are electrically charged and urged toward deposition upon the articles by the effect of the field. This process substantially reduced over-spray loss and labor expense, and in many commercial applications was a substantial improvement over conventional non-electrostatic painting methods. In 1944 the partnership commenced marketing the No. 1 Process, which was the first commercially used electrostatic spray painting system.

10. The equipment required by a user of the No. 1 Process includes, in addition to such conventional items as conveyors and ovens (none of which has at any time been supplied by defendant), a voltage source, or power pack, capable of an output in the order of 90,000 volts. At the time when the partnership was ready to license others to use the process, none of the power packs available on the market was deemed by it to be sufficiently safe for use in the process, nor were any suitable combined electrical and paint supply controls available. Because of the unavailability of these items on the market, the partnership designed and produced a safer power pack and suitable combined controls, so as to be in position to interest prospective licensees in the process. The agreement licensing the user to use the process provided that Ransburg would furnish on essentially a lease basis the specialized power pack, controls, electrodes, insulating electrode supports, and high-voltage lead-in means. The necessary spray guns and other conventional equipment were not supplied by Ransburg, but were purchased by the licensees from plaintiff and other suppliers.

11. While the No. 1 Process was a definite improvement over non-electrostatic air spray coating, considerable loss of coating material persisted in many applications because the electrostatic field only partially counteracted the tendency of the compressed-air blast to carry much of the material elsewhere than upon the articles being coated.

The Ransburg partnership continued its research and development work, and as a result thereof developed its No. 2 Process, by which articles could be coated electrostatically without the necessity of compressed-air spray guns to atomize the material. In this process, in substance, the electrostatic field is maintained directly between the atomizing device, or head, and the articles on the conveyor. The coating material is fed at a controlled rate to and distributed along the extended edge of a stationary or rotating atomizing head. The strength of the field at the edge is such that the field is capable of electrostatically atomizing fine, electrically-charged particles from the liquid. The field then disperses those particles in the form of a spray, and deposits them upon the articles of manufacture. This process, in many applications, virtually eliminates over-spray, and thus paint loss, further reduces labor costs, and substantially reduces the manufacturer's investment in spray booths, exhaust systems, and related equipment. The first license of the No. 2 Process was granted by defendant in 1949, under a special consulting and research agreement with Enameled Steel and Sign Company of Chicago, Illinois. General marketing of the system was commenced in 1951. Inasmuch as the special paint atomizers and accurately controllable paint supply systems required for operation of the No. 2 Process were not available on the market, defendant designed and produced them and furnished them to licensees as part of the specialized equipment.

Plaintiff's Activity in the Art Field of Electrostatic Spray-Painting.

12. The plaintiff has for many years and is presently manufacturing and selling spraying equipment for paint and other materials in this District and elsewhere in the United States. With its predecessors, it has been in busi-

ness since 1892, has branch offices or warehouses in twenty-eight major cities in the United States and Canada, sells a line of merchandise under the slogan "Everything for Spray Painting," and is one of the two largest merchandisers of spray-painting equipment in the United States. It sells, and for many years has sold, a large volume of compressed-air spray guns, for both manual and automatic operation, and in many instances sells complete finishing facilities as a package, including spray guns, spray booths, paint-collecting devices, exhaust systems, and related equipment. In 1958 it added to its advertised line of products electrostatic spray-painting equipment of the compressed-air spray type.

13. Plaintiff's first knowledge of a method for painting by the use of compressed-air and an electrostatic field was attained in the late 1930's or early 1940's from knowledge of the system developed by defendant's predecessor, and in December, 1942, at the invitation of the latter, several of plaintiff's representatives attended a demonstration of the Ransburg air-type No. 1 electrostatic coating system at Indianapolis, Indiana. Plaintiff's first knowledge of an airless electrostatic painting process was obtained from defendant's No. 2 system, after it was commercialized.

14. After discussions of the subject of electrostatic spray painting, plaintiff purchased a power pack in January, 1951, and its personnel first carried out experiments in that year. Its research was sporadic until April, 1952, when it hired for that purpose James H. Rice, who began by reviewing all of the patents in the field. Also in 1952 it negotiated with William A. Starkey, a co-patentee of the patents in suit, and Harry Green, former research employee of defendant, with a view of employing them, but no agreement was reached. During 1951 and 1952 plaintiff gave consideration to acquiring the business of Ashdee Electrostatic Products, Inc., which was in the business of

marketing air-type electrostatic spray coating systems in competition with the defendant's No. 1 and No. 2 systems, but the negotiations were terminated. In 1953 plaintiff retained Midwest Research Institute, of Kansas City, Missouri, to do research for it on electrostatic spray-painting and to develop a new or improved spraying technique; such research was performed in 1953 and 1954.

15. Plaintiff's efforts culminated in the development of an atomizing head or emitter, designated SK661, a drawing of which was made and dated on May 12, 1954. This emitter is intended for use in an airless electrostatic coating system which is the subject of the charge of infringement in defendant's counterclaims.

16. After plaintiff learned of the issuance of defendant's Starkey method patent, No. 2,685,536, which was issued on August 3, 1954, its work in the field of airless electrostatic spray-painting became dormant until the negotiations with Ford Motor Company which are hereinafter referred to.

17. The only equipment which plaintiff has attempted to market for airless electrostatic spray-painting is its SK661 emitter and the equipment related thereto, and the only prospective vendee to which plaintiff has attempted to sell such equipment is the Ford Motor Company. In response to a request by Ford, plaintiff on January 25, 1956, quoted its price upon such equipment with the express proviso:

> "This bid shall not be binding upon Binks Manufacturing Company as an offer unless and until Ford Motor Company shall indemnify Binks Manufacturing Company and hold it free and harmless against any and all suits or causes of action which may be brought against Binks Manufacturing Co. for infringement and/or contributory infringement of Starkey et al. patent 2,685,536 by reason of manufacturing and fur-

quishing to Ford Motor Company the devices comprising the subject matter of said bid or by use by Ford Motor Company of said devices."

Ford did not purchase the equipment.

18. In July, 1956, plaintiff initiated correspondence with defendant, stating that it was "ready to market a paint sprayer which electrostatically atomizes the paint without making use of air," and asking that defendant send its standard license form. When defendant submitted its standard No. 2 Process license forms 439 (with equipment) and 440 (without equipment), plaintiff sent defendant a print of its SK661 drawing of May 12, 1954, said that neither form would be satisfactory, and stated that it was interested in "a license to make and sell equipment for this type of spray painting under your Starkey patent" No. 2,685,536. Plaintiff further advised defendant that form 440 was not acceptable to plaintiff because it required "continuous periodic payments of royalties based on the extent of the coating material used," and that plaintiff's sales practice was "such that any license agreements that we might enter into would have to require the payment of only one royalty at the time of each sale so that thereafter the customer's use of the equipment would be free of any further royalty payments," and asked that defendant consider "granting a license requiring, in the instance of each sale of spray equipment, only a single royalty payment at a given rate of percentage of the sales price." In reply defendant stated in its letter of September 21, 1956:

> "* * * Granting licenses on this basis would require a complete change in our marketing policy and a change of all our licenses now in effect, as otherwise a large part of our licensees would be treated unfairly. We also believe that the system you suggest is not satisfactory for determining the proper value for the use of the process.

"In view of the foregoing we trust you can readily understand why we feel that we cannot comply with your request. We want you to know that licenses are available to your customers for painting with our method and we assume you will not furnish the equipment which has been the subject of this correspondence to such customers unless they are licensed by us."

Thereafter, on October 11, 1956, plaintiff filed the complaint in this cause, seeking a declaratory judgment that the Starkey process patent was invalid and alleging misuse of the patent, anti-trust law violations, and unfair competition by defendant.

Nature of the Patents in Issue and Their Position in the Art.

19. In the No. 1 Process, which defendant's predecessor had developed in the late 1930's, articles to be spray-painted were conveyed past an electrode. The articles were grounded, while an electrical potential on the order of 90,000 volts was applied to the electrode to create an electrostatic field between it and the articles moving past it. A paint spray formed outside that field by conventional compressed-air spray guns was directed into the field with the result that the sprayed particles acquired electrical charges which caused them to be attracted to the articles. While this system reduced losses of paint as compared with the older non-electrostatic spray-painting systems, the air employed to form the spray and project it into the field had to escape from the coating zone and carried away with a substantial portion of the paint sprayed. Spray booths and other equipment were still necessary to handle the paint escaping as overspray from the coating zone. Even with the benefit of electrostatic forces, paint losses in this method of spray painting may amount to as much as about one-third of the paint sprayed.

20. The systems illustrated in the patents in suit eliminated the air streams which caused substantial paint losses even in the No. 1 Process. In each of such systems, the paint is supplied to and oozes at a controlled rate from the inside to the outside of an atomizer which is maintained at an electrical potential corresponding to that impressed on the electrode in the above-described No. 1 system: The articles to be coated are conveyed past atomizer and maintained at ground potential to create an electrostatic field between them and the paint fed from the interior of the atomizer. Such paint is atomized electrostatically into a spray of finely-divided, electrically-charged particles which are electrostatically deposited on the articles. These systems, which exemplify the "No. 2 Process," employ no air for atomizing the paint or forming the spray, reduce paint losses to 1% or 2% of the paint sprayed, and can be practiced in the open shop without the necessity for expensive paint exhaust and overspray recovery equipment.

21. All forms of atomizers shown in the two patents in suit provided for electrostatic atomization of the paint at individual points of a series of points disposed in a row. In the form of atomizer shown in Figs. 5 and 6 of the patents in suit, the paint oozes through orifices in the head and forms a continuous film which is supported by a row of needles projecting downwardly from the head and which bridges the spaces between the spaced points where the atomization occurs.

22. Patent 2,685,536 in suit is directed to methods of electrostatically spray painting without the use of air. It contains eleven claims, all of which, with the exception of Claims 7 and 9, are asserted by defendant to have been infringed by plaintiff. Claims 1, 2, and 10 have been treated as typical.

23. Patent 2,794,417 in suit is directed to forms of ap-

paratus for use in practicing the method of the other patent. It contains four claims, but only Claim 4 is relied upon by defendant as having been infringed by plaintiff.

24. The original application Serial No. 556,390 filed September 29, 1944, which resulted directly in patent No. 2,685,536 and indirectly in patent No. 2,794,417, had extended prosecution and careful consideration at the hands of the Examiner and Board of Appeals of the Patent Office. A total of 22 references were cited against it, and it was twice considered by the Patent Office Board of Appeals before being allowed. Included in the prior art cited against it were references showing the electrostatic deposition of paint and other particles suspended in air streams and at least one reference showing the electrostatic atomization of liquids.

25. Any spray-painting operation requires that the paint be atomized at an adequate rate, that the atomized particles be formed into a spray of suitable shape and size, and that the spray particles be small enough to avoid creating a rough finish and large enough that their volatile constituents will not evaporate to such an extent that the deposited particles are too dry. The method of patent 2,685,536 in suit meets those requirements and has been widely used in industry to paint a variety of types of articles including automobile chassis and shock absorbers, light fixtures, furniture frames, and cabinets for domestic refrigerators and laundry appliances.

Prior Art.

26. The prior art relied on by the plaintiff does not contain anything constituting a complete anticipation of any of the claims in suit. Every prior art apparatus or method lacks one or more of the features required by each such claim.

27. The prior art may show apparatus with which the

method described by the claims of patent 2,685,536 in suit could be practiced and may further show that some features of that method were separately old; but the prior art fails to suggest to one skilled in the art any use of old apparatus to practice the method claimed or to suggest that individually old method steps could be combined to produce a practicable usable paint spraying method wherein a single electrostatic field maintained between an atomizer and an article to be coated would atomize paint into fine particles, disperse those particles and form them into a well-defined spray, and deposit the spray-particles electrostatically on the article.

28. Among the separately old features of patent 2,685,536 is electrostatic atomization, which is disclosed in Darrah patent 1,958,406 (1934), in the Zeleny articles published at various times from 1914 to 1935, in the Proceedings of the Royal Irish Academy (Vol. XXXIX, 1929), and in the London, Edinburgh & Dublin Philosophical Magazine (Vol. 23, 1887). None of this prior art suggests that electrostatic forces would atomize liquids like paints and enamels or that, if such atomization was possible, the atomized particles would be formed into a spray of the type required in painting operations. Although electrostatic atomization was known for over half a century, it is not shown to have been put to any practical use prior to the inventions of the patents in suit.

29. Instead of suggesting the applicability of electrostatic atomization in spray painting, the prior art gives many indications that it would be unsuitable for that use. Among such indications are:

a. The indication in the 1915 Zeleny article (p. 75) that deposition of the atomized liquid on the oppositely charged electrode occurred only "after * * * some time."

b. At the highest rate of atomization mentioned in the prior art, about six to eight weeks of continuous operation would be required to atomize one pint of liquid.

c. The statement in the 1914 Zeleny article (p. 72) that in electrostatic atomization "the choice of liquid * * * is confined to such liquids as do not leave a residue on evaporation." Any paint, enamel or other permanent coating is such a residue.

d. The statement in the Darrah patent that electrostatic atomization "produced particles of liquid so small that they appear to remain suspended indefinitely in air."

30. None of the prior art is any more pertinent in respect to electrostatic atomization than the Darrah patent 1,958,406 which was cited by the Patent Office against the application that resulted in method patent 2,685,536 in suit. Darrah surrounded one or more capillary nozzles with a ring-like electrode and created between that ring and the liquid in the nozzles an electrostatic field which atomized the liquid as "an exceedingly fine spray." So far as the patent indicates, such spray was projected forwardly beyond the ring electrode and there was no electrostatic field promoting the deposition of the spray so projected on any article to be coated. Darrah, an inventor, a graduate Electrical Engineer with many years experience, and a registered patent agent who has prosecuted over 100 United States patents, experimented with electrostatic atomization for some time, but abandoned his work when he was unable to conceive of any practical use for the phenomenon.

31. No prior art discloses atomization from a plurality of points so closely spaced as to form a substantially continuous atomizing zone, as taught and claimed in the patents in suit. One reference, Darrah, does show atomization at a plurality of points, but the distance between his points

was greater than their distance from the oppositely-charged ring electrode, and hence well outside the close point-spacing contemplated by claims in suit.

32. In the prior art disclosure of electrostatic atomization or anything approaching it, the liquid was either contained in an open dish or fed through capillary tubes, and no means was provided to feed the liquid to the atomizing site at a controlled rate, as required by all the claims in suit and as is necessary in any practical painting operation.

33. In prior art electrostatic atomization, the atomization was carried out either at a single point or at a plurality of points so widely spaced that the distance between them was greater than the greatest distance between any of them and the oppositely-charged electrode. The resultant concentration of lines of force at each point of atomization provided the greatest possible field intensity. The patentees of the patents in suit discovered that the lower field strength existing with the closely-spaced points of atomization disclosed in the patents in suit would atomize liquid coating materials at commercially usable rates.

34. Electrostatic deposition of paint and other coating materials is shown in such prior art as the Pugh patent 1,855,869 and Ransburg, et al. patent 2,247,963. In all such art, the coating material was atomized or comminuted by mechanical means (compressed-air spray guns in the case of liquid coating materials), suspended in an air stream and carried by that air stream into the electrostatic field which urged it toward deposition on the work. No electrostatic atomization occurred in such systems, and the air used to atomize and or carry the coating materials into the field had to escape therefrom and carried much of the coating material with it.

35. The Littlefield patents 1,360,654 and 1,854,475 disclose devices intended to produce a spray of electrically-

charged liquid particles. Each device embodies a spray nozzle having orifices through which liquid is forced to form a spray and, in association with such nozzle, an electrode between which and the nozzle a difference of electrical potential was maintained. Such field as existed was in the vicinity of the orifices. The statements by Littlefield to the effect that an electrostatic field can form into a spray a jet of fluid discharged into it is not supported by a teaching of any means for securing that effect and, in any event, is no more significant than the Darrah disclosure.

36. The Gravley patent 2,359,476 discloses a "detearing" or "decoating" method and apparatus used to remove excess paint or the like from an article which has been treated, as by dipping, with such an excess. The paint collecting as "tears" on such an article under the influence of gravity is drawn from the article by electrostatic attraction to a charged grid, which is a part of the apparatus. Gravley's statement that the material may leave the article as large drops, small drops, or even in a practically atomized state does not suggest the subject matter set forth in the claims of the patents in suit. Gravley does not supply liquid at a controlled rate to an atomizing site; and his mention of the production of large and small drops, which are objectionable in spray painting, teaches that electrostatic forces are not suitable for the use to which they were put by the patentees of the patents in suit. Gravley was thoroughly considered by the Patent Office in the prosecution of the method patent in suit, but was discarded.

37. Heis patent 1,475,995 deals with a method and apparatus wherein gaseous substances are passed through an electrostatic field to promote chemical reactions, and the patent is, therefore, in a remote art. This reference does not disclose an atomizer and would not suggest to one skilled in the art of spray painting that anything it discloses would be useful in the spray painting of articles.

38. The Winternute patent 2,221,338 discloses a system in which "finely divided material such as rayon flock" or "self-adhesive materials such as wax" are fed into an air stream which impinges perpendicularly upon a sheet that is to be coated. An electrode is mounted on the nozzle through which the air stream discharges and the particled material is "prevented from leaving the zone of deposition with the current of air passing off laterally by the curtain of corona discharge." The patent does not disclose or suggest the subject matter of any of the claims in suit.

39. The publication "Electrical Experiments, Francis, 5th Edition" discloses that electrostatic forces can be used to spin threads from molten sealing wax. It is in no way pertinent to the patents in suit.

40. Method patent 2,685,536 in suit is for a broad, basic invention fundamentally different from any previous spray-coating process of record here. The subject matter defined by each of its claims 1 to 6, 8, 10 and 11 in suit, is novel and involves invention over anything disclosed in the prior art.

41. Claim 4 of apparatus patent 2,794,417 in suit describes electrostatic spray coating apparatus wherein there is maintained between an atomizer and the work an electrostatic field capable of atomizing the liquid-coating material and depositing the atomized particles on the work. An important feature of the claim is means for distributing the unatomized coating material to a plurality of points of atomization so close together that the liquid bridges the spaces between them. Such a feature, which promotes uniformity in the distribution of liquid to the several points where atomization takes place, is inherent in Figs. 5 and 6 of the patents in suit, is novel, and involves invention over the prior art.

42. The subject matter defined by the claims of the

patents in suit has filled a long-felt want, and methods and apparatus embodying such subject matter have found wide use in industry. Hundreds of companies, including some of the largest in the country, have paid the defendant substantial fees for the right to use such subject matter. While the specific atomizers used in defendant's commercial spray coating systems differ in detail from the specific atomizers shown in the patents in suit, the commercial systems all embody the fundamental concepts to which the claims in suit are directed, and the commercial success the systems have enjoyed is to be credited basically to the inventions those claims describe.

Other Issues of Validity.

43. The specification of each of the patents in suit contains a description of the invention adequate to enable it to be practiced by those skilled in the art of spray painting, particularly electrostatic spray painting. While the specifications do not expressly set forth such factors as type or grade of paint, voltage, rate of paint feed, distance between the work and the electrode (atomizer), and rate of conveyor movement, the disclosure is operable when such factors are made comparable to those used in prior electrostatic spray coating systems.

44. The Starkey and Ransburg patents in suit are for inventions different from and antedating that of Ransburg patent 2,658,009. The latter patent is directed and limited to a methods and apparatus employing an auxiliary electrode to shape a spray such as is produced in practicing the invention of the patents in suit.

45. The two patents in suit are for inventions different from each other. While the contemplated operation of apparatus patent 2,794,417 inherently involves the method claimed in patent 2,685,536, that method can be practiced

by forms of apparatus outside the scope of claim 4 of patent 2,794,417.

46. The claims of the patents in suit are amply supported by the common specification of those patents, are neither deceptive nor misleading in character, and are not broader than the disclosure.

47. The claims of both patents in suit are directed to inventions made by the joint patentees and not by others.

48. The claims in suit are not drawn to mere aggregations of old process steps or apparatus elements, but to combinations in which the recited process steps or apparatus elements cooperate with each other to the attainment of a common purpose.

49. Although application 536,390 from which both patents in suit resulted, was not filed until September 29, 1944, the patentees had, in 1943, built and operated airless electrostatic spray painting apparatus embodying an atomizing head substantially like that shown in Figs. 1 and 2 of the patents.

50. Defendant had knowledge of all prior art asserted by plaintiff in its second defense prior to the issuance of patent 2,794,417, some of which was referenced by the United States Patent Office in patent 2,794,417 and the method patent in issue of which it is a division, and none of the alleged prior art anticipated the claims of patent 2,794,417. Defendant made no misrepresentations and did not withhold knowledge from or to the United States Patent Office of any prior art anticipating one or more claims of the application which issued as patent 2,794,417. The inventive concepts of method and apparatus patents in issue as pointed out in these findings and in the opinion are not precisely identical. The defendant pursuant to its option of covering them in separate patents or in a single patent elected to voluntarily cancel the claims and application for the apparatus patent in patent 2,685,536. The

defendant also voluntarily cancelled certain of the claims of its application which thereafter resulted in apparatus patent 2,794,417.

51. In finding 18 reference is made to certain correspondence between plaintiff and defendant which has been made the subject of plaintiff's fifth defense of its substituted answer to defendant's substituted supplemental complaint and concerns only the defendant's apparatus patent in issue.

The file history of this patent discloses that the Examiner of the United States Patent Office on January 17, 1956 made a final rejection of certain claims of the application over Formhals patent 2,187,306 in his paper No. 9. Thereafter another firm of attorneys in Chicago, Illinois, were requested by defendant to look over the file to determine whether or not all the claims the applicant was entitled to were allowed. One of the members of the firm was assigned the task and he took the file to his home on the holiday of July 4, 1956, and he determined from such study that defendant was entitled to another claim and drafted one in longhand.

On July 3, 1956, the plaintiff sent the first letter referred to in finding 18 to defendant at Indianapolis which is quoted as follows:

"Gentlemen:

> We have fully developed and are ready to market a paint sprayer which electrostatically atomizes the paint without making use of air. Since we understand from the trade you have a standard form of patent license, we would appreciate your sending us a copy if your licensed patent is applicable to such a sprayer.
>
> Awaiting your reply, we are
>
> Very truly yours,
>
> John W. Baur,
>
> *Chief Engineer, Std. Equipment.*"

On July 5, 1956, the attorney had an office conference with his partner and other patent attorneys of defendant at which a claim was drafted from that of July 4, 1956 and he was authorized to go to the United States Patents Office to interview the hearing Examiner.

The file history discloses that on July 13, 1956, the defendant prepared and filed on July 16, 1956 its appeal to the Board of Appeals such final rejection by the principal Examiner.

On July 24, 1956, the attorney was in Washington and consulted with the hearing Examiner at which time the attorney drafted a claim which included the expression: "sufficiently close to permit the coating material to bridge the spaces therebetween."

On July 25, 1956, another one of the defendant's letters referred to in finding 18 was sent to plaintiff at Indianapolis and contained an enclosure, a print of its emitter.

On August 8, 1956, the attorney had a meeting with defendant's other patent attorneys in Indianapolis at which he submitted the claim draft of the Washington meeting with the hearing Examiner and after some other non-relevant changes was authorized by defendant to prepare and file such as an amendment to the application for the apparatus patent in issue.

The file history discloses that on August 21, 1956, the attorney prepared and on August 23, 1956 filed with the United States Patent Office Amendment "C" to the pending application containing among other amendments a claim and an addition to the specification the same expression developed in the draft of the claim in Washington on July 24, 1956. In the remarks accompanying the amendment it is recited:

"Remarks:

Applicants' attorney desires to express his appreciation for the courtesies extended to him at the recent interview with the Examiner in charge of the application.

At the interview, the final rejection of the claims on the grounds stated in paper No. 9 were discussed at some length and a new claim (here submitted as claim 18) was also discussed.

It was pointed out that one of the features of the suggested new claim is the provision of feeding means which distribute coating material to an extended atomizing zone from which zone it is atomized from a plurality of spaced points with the points being so close together as to permit the coating material to bridge the spaces therebetween. Such, of course, is not the system of Formhals, as, regardless of the spacing of his nozzles, the coating material being contained within the nozzle could not bridge the space therebetween. Serial No. 434,366 • • •

It was suggested by the Examiner that the obviously inherent bridging of the coating material at least in the apparatus illustrated in Figures 5 and 6 be pointed out in the specification and accordingly the specification has been amended to do so.

The unallowed claims remaining in the application are proposed to be cancelled with this amendment and it was believed at the interview that an action of this nature by applicants would place the case in condition for allowance.

Therefore, withdrawal of the final rejection, entry of the present amendment, and reconsideration and allowance of the application as now presented are respectfully requested."

Amendment "C" was accepted by the Patent Office and the patent thereafter issued on June 4, 1957 with Claim 4, being Amendment "C."

The attorney, responsible for the drafting of Claim 4 and whose language and expression it was, had never seen the correspondence and the emitter print of the plaintiff's referred to in finding 18 on or before July 24, 1956 and none of defendant's officers, agents and employees imparted such expression or suggested the substance thereof to the attorney. None of the correspondence nor did the print of the emitter contain such expression adopted by the attorney in the amendment nor did it suggest such to the attorney.

The disclosure of plaintiff's emitter by the correspondence referred to in finding 18 to defendant was not made in confidence.

The defendant was not guilty of any inequitable and unethical business conduct in adopting the expression in Claim 4. The defendant was not guilty of wrongfully appropriating any disclosure of plaintiff in this transaction. The defendant was not guilty of any unconscionable conduct in this transaction. The defendant did not wrongfully profit from this transaction. The plaintiff suffered no detriment and damage from any wrongful conduct of defendant in this transaction.

Infringement.

52. The method herein charged to infringe method patent 2,685,536 has been used in the United States by plaintiff subsequent to August 3, 1954, the date on which that patent issued. The apparatus charged to infringe apparatus patent 2,794,417 has been used in the United States by plaintiff subsequent to June 4, 1957, the date on which that patent issued.

53. Plaintiff's accused method and apparatus employ an atomizer comprising two coaxial metal disks spaced about 0.007 inches apart, presented edgewise toward the article and spaced from the article by a distance of about

15 inches. The article is grounded while a high-voltage source connected to the atomizer creates an electrostatic field between it and the article. Liquid coating material supplied at a controlled rate near the center of the disks is formed into a film in the space therebetween and flows radially outward to the disk periphery. A spacer or shim between the disks confines the liquid film to a portion of the disk circumference. At the periphery of the disks, the field draws the edge of the film into a series of aligned, closely-spaced cusps and atomizes finely-divided, electrically-charged particles from the tips of such cusps. The field then disperses the atomized particles and deposits them on the article.

54. While in all the specific embodiments of the method and apparatus disclosed in the patents in suit the liquid emerges from the interior of the atomizing head through a plurality of orifices and is mechanically divided or concentrated into more or less discrete droplets from which the atomization takes place, the method claims in suit are not limited to feeding the liquid through a plurality of orifices or to the concentration of the liquid into more or less discrete droplets. Similarly, Claim 4 of the apparatus patent in suit is not limited to apparatus embodying an atomizer which has a plurality of feed orifices or mechanical provision for concentrating the liquid into droplets.

55. The "points" at or from which atomization is required to take place, in accordance with the terms of Claims 1, 5, 6 and 8 of the method patent and Claim 4 of the apparatus patent in suit, are points in space and not physical or structural features of the atomizer. Plaintiff does not avoid such claims by presenting the liquid coating material to the field as a uniform film edge and allowing the field to form it into cusps and thus determine the spacing of the points at which atomization occurs. Neither are the claims avoided by the fact that in the use of the

accused method and apparatus the location of such points may vary.

56. The accused method meets every requirement of each of the claims in suit of method patent 2,685,536.

57. The accused apparatus meets every requirement of Claim 4 of apparatus patent 2,794,417 in suit.

58. Plaintiff's accused method and apparatus were developed with full knowledge of defendant's method and apparatus embodying the inventions of the patents in suit. Plaintiff's method and apparatus did not spring from the prior art, but represent an adoption of the basic concepts first invented and usefully applied by the patentees of the patents in suit.

59. Nothing in the prior art or in the prosecution of the applications which resulted in the patents in suit requires any of the claims in suit to be limited to exclude the accused method and apparatus.

Alleged Misuse of the Patents in Suit (Fourth Defense to Supplemental).

60. Defendant has employed essentially the same marketing system and licensing practices from the time of its organization to the present. It seeks to interest prospects in its coating system by advertising in trade publications, by the distribution of sales brochures, and by direct solicitation, in all of which it refers to its systems as the No. 1 and No. 2 "processes." If a prospect expresses interest, defendant obtains from him data on his product, his coating material, the type and thickness of finish desired, his paint "mileage" (finished units per gallon) under existing procedures, his conveyor, and other relevant factors, and invites him to submit samples of his products for a laboratory test.

61. The electrostatic spray coating needs of defendant's prospective customers vary substantially, depending

upon the nature and size of the article to be coated, the coating material to be used, the type of finish desired, and other production considerations. In defendant's laboratory a painting operation is designed, set up, and operated for the prospect without obligation, employing his products and coating material and simulating the conditions existing or contemplated in his plant. From this pilot operation, anticipated coating material savings are computed and the application and quality of the finish are demonstrated to the prospect. If the prospect remains interested, defendant's engineers then make a drawing of the system and apparatus arrangement demonstrated to and desired by the prospect, and a proposed agreement is submitted to him on one of defendant's standard printed agreement forms.

62. The agreement licenses the customer, or user, to use the particular system shown schematically in the identified engineer's drawing for the purpose of coating the articles specified, and is terminable by the user at any time upon a thirty-day notice, and by the defendant at any time after three years upon a six month notice. Under the terms of the agreement, when desired by the prospective customer, defendant furnishes, on essentially a lease basis, the specialized equipment necessary for the operation of the system designed for him, sends its engineer to supervise installation in the user's plant, and undertakes to replace parts which become defective.

As consideration for the foregoing, a license of the No. 2 Process pays: (a) an initial fee which varies with the design of the system and apparatus licensed, and (b) monthly fees representing a portion of the user's savings resulting from the use of the system. The size, shape, and contour of the article to be coated determine the quantity of paint which can be saved through use of the system, and defendant has classified articles of manufacture on this basis. The monthly fee is computed as a

percentage of the cost of the coating material used in the system by the user, which percentage depends upon the class into which the article falls and is in proportion to the potential paint saving in coating that article. In practice, this formula, as applied to each individual user, results in his paying for the use of the system compensation related to the actual benefit to that user in his particular operation, subject to a specified minimum.

The initial fee of a No. 1 Process licensee varies with the number of air-spray guns which are to be used, and the monthly fee consists of a fixed minimum amount, plus a percentage of the cost of the coating material used in the system by the user, which percentage is uniform for all users and decreases as the quantity of material used increases.

63. In the event any prospective user would not desire that defendant furnish the specialized equipment, installation supervision and parts replacement service, but would desire a license under defendant's applicable patents to use one of the aforesaid systems, defendant will grant such non-equipment license by means of a different standard printed form agreement, in consideration of substantially lower initial and monthly fees.

64. Satisfactory performance of defendant's systems depends upon the character and quality of the specialized equipment incorporated therein. Defendant recommends its systems and enters into license agreements only where its analysis shows that the system will perform satisfactorily for the licensee, effect significant savings, and reflect credit upon the process. Where the license agreement requires defendant to furnish such equipment, supervise its installation, and replace defective parts, defendant, as a matter of standard business policy, guarantees to the user that the system will coat the user's articles to his

satisfaction, and will permit the user to terminate the agreement with refund of fees if the system does not do so.

65. Although much of the specialized equipment required for the practice of defendant's processes was and is not available on the open market and defendant has produced the same and furnished it to its licensees in order to be able to market its processes, it has always been the express policy of the defendant, and so understood by all of its officers and sales and management personnel, that if a prospective licensee preferred to obtain equipment elsewhere than from defendant, he was free to do so and at reduced fees could obtain a license from defendant without equipment, installation supervision, or part-replacement service. This policy was expressed to all distributors and salesmen in a bulletin issued by the Ransburg partnership on August 29, 1947, and has been reiterated by defendant in bulletins of August 18, 1950; May 27, 1953; July 15, 1953; May 13, 1954; April 4, 1955; and June 6, 1956. Although no prospect of defendant had ever expressed interest in a license without equipment, in 1953 it prepared and stocked standard printed contract forms for licenses without equipment as to each process; instructed its sales personnel to advise all prospective customers that non-equipment licenses were available; and informed its existing licensees by letter that should they desire to return defendant's equipment and retain only a license, their monthly fees would be reduced by stated amounts. Those licensees with whom agreements had been consummated, but who had not yet paid the initial fee, were informed that the initial fee would also be reduced by a stated amount. Again on May 13, 1954, salesmen were reminded by bulletin to advise all prospective customers that they could obtain a license without equipment for reduced initial and monthly fees. Since 1953 defendant's sales brochures describing the No. 2 Process have stated

that defendant will supply the equipment "when desired," and are handed or mailed to virtually every prospect and distributed at defendant's display at trade shows at the rate of approximately 10,000 copies per year. When proposed agreements providing for equipment are transmitted to the prospect, the letter points out that the agreement so provides, and states that defendant understands that the prospect prefers this contract to one under which the equipment is not furnished. Defendant thus takes steps to inform its prospects in writing of the availability of process licenses without equipment upon the initial contract, and again when transmitting the proposed agreement for execution.

66. The defendant has never at any time required that any person desiring a license under either of the patents in suit, or any of its other patents, must obtain from it, or pay for, equipment, installation supervision, or part-replacement service as a condition to the granting of the license. No prospective licensee has requested a license to practice the process without defendant's furnishing equipment, or that any such prospective licensee has been refused such a license.

67. As of the filing of this cause, defendant has granted 733 electrostatic coating licenses, of which 463 were still in force and effect. Defendant has been required to furnish equipment by all agreements licensing air-type systems except (a) the license to Hillgren Manufacturing Company, Huntington Park, California, granted as part of the settlement of defendant's suit against Hillgren for patent infringement, and licensing the use of defendant's process with infringing equipment previously acquired elsewhere by Hillgren, and (b) a few agreements whereby existing licensees who ha ddefendant's equipment under a prior agreement were granted licenses to use the process for additional or extended purposes by means of equip-

ment procured by themselves and connected by them to defendant's previously-furnished power pack. All No. 2 Process license agreements have included equipment.

Because of the desire of the prospective licensees to have a satisfactory working system, which will perform as demonstrated in defendant's laboratory, the licensees prefer to have defendant supply the equipment. The evidence shows that 55 of defendant's licensees who received the 1953 letter advising that they could have a non-equipment license if they so preferred, subsequently executed 97 agreements for additional licenses and in every case chose an agreement requiring defendant to furnish the equipment. No licensee of the defendant, at the time the license agreement was consummated, did not prefer an agreement under which defendant would furnish equipment to one under which it would not. Nor has any licensee been in any manner coerced into taking undesired equipment, installation supervision, or part-replacement service as a condition to the grant of a license.

68. The equipment supplied by defendant to its licensees consists of the minimum specialized equipment needed for use of the particular systems licensed. The equipment, as a whole or combination, has no other substantial use.

69. Defendant does not sell equipment outright. It has never licensed anyone under its United States patents to make and sell electrostatic spray-coating systems.

70. No terms for licenses with or without equipment are quoted by defendant to prospective licensees unless such prospects express interest therein or request quotations. No prospective licensee ever expressed interest in, or requested, quotations on a No. 2 Process non-equipment license prior to defendant's quotation of March 23, 1954 to Webster Chicago Corporation.

Thus, the terms upon which defendant would have quoted a No. 2 Process non-equipment license, had a request

therefor been made, were academic until 1954. However, the pricing schedule established by defendant in 1953 and 1954 included rates for non-equipment licenses. The initial fee for a license with equipment ranged from $8,100 to $12,500 per unit, depending upon the type and complexity of the system designed; whereas a non-equipment license was available for an initial fee of $4,100. The minimum monthly fee without equipment was correspondingly less than if equipment were furnished. Whenever any prospective licensee requested quotation of non-equipment license terms, or showed interest in them, defendant quoted such terms. Any terms quoted to any prospect for a non-equipment license made due and proper allowance for elimination of the equipment and related services not to be furnished thereunder.

Alleged Package Licensing.

71. Defendant's license agreement forms do not identify the specific patents under which the user is licensed, but grant a right or license to use an identified process (with or without compressed-air) to coat particular items in accordance with the specially-designed system shown in the identified drawing. The defendant has never required any prospective licensee, as a condition to receiving a license under any patent, to take or pay for any license under any patent which did not apply to the system described in the license agreement. No prospective licensee has ever requested a license under any of defendant's patents which defendant has refused to grant such license unless such prospective licensee also takes or pays for a license under one or more other patents. No licensee of defendant has at any time received or paid for a license under any patent which did not apply to the system described in the license agreement.

Alleged Violation by Defendant of the Anti-Trust Laws and Unfair Competition.

72. On April 7, 1943, the Ransburg partnership purchased from Western Electric Company, Incorporated, the Pugh patent 1,855,869, subject to a license reserved to Western Electric and Bell System companies, which patent had not been, and was not then being, used in the seller's manufacturing operations. This patent, which expired on April 26, 1949, was for a method of and apparatus for coating articles, wherein articles on a conveyor passed through a closed chamber, into which a compressed-air atomized spray of coating material was introduced, the spray nozzle and articles being connected to a source of electrical energy of high potential, giving the sprayed particles a charge opposite that of the articles and attracting them to the uncoated portions of the articles. The partners deemed it advisable, if not necessary, on advice of counsel, to acquire this patent or a license under it in order to permit them to proceed with their development of their air-type No. 1 Process and to market it free from danger of possible infringement charges; and they purchased the patent for $5,000, and the defendant retained it until its expiration, with that purpose and intent.

73. In settlement of interference proceedings No. 80,369 in the United States Patent Office, between patent applications of Harold P. Ransburg, Serial No. 366,529, and Charles K. Gravley, Serial No. 313,914, the Ransburg partnership entered into an agreement of May 3, 1943, with the Brush Development Company, Cleveland, Ohio, under the terms of which, for cash and other consideration, Brush sold to Ransburg the Gravley application, upon which United States patent No. 2,359,478 issued on October 3, 1944. This patent is upon an electrostatic method and apparatus for removing excess coating material from arti-

cles previously coated by dipping. Its acquisition by the partnership and retention by the defendant did not damage the plaintiff, who has at no time attempted to market detearing devices.

74. When the Ransburg partnership was in the intial stages of marketing its air-type No. 1 Process, it received from Behr-Manning Corporation, Troy, New York, a leading manufacturer of sandpaper and abrasives, a written notice dated November 22, 1940, stating that some of the latter's patent coverage was directed to the art of "electrodeposition of paint or other liquids," and suggesting a meeting to discuss the matter. Behr-Manning's patents pertained primarily to the manufacture of abrasives and flock-coated articles. However, after the parties had engaged in some discussions, the Smyser patent 1,788,600, which was issued originally on January 13, 1931, upon a method for electrostatically making abrasive articles and appartus therefor, was reissued on January 11, 1944 (Re. 22,419), with claims extending to the electrostatic coating of articles as practiced by the Ransburg partnership. Two of such claims were indentical to claims originally issued in the Pugh patent, and might conceivably have been asserted against the Ransburgs and their air-type No. 1 Process customers. Behr-Manning owned the rights to said Smyser reissue patent. The Ransburg partners were concerned about these obstacles to their development and marketing, as expressed in their letter to Behr-Manning of July 3, 1944, as follows:

> "Notwithstanding the wide separation of the fields in which we have been operating, it is easily possible that certain aspects of our patent protection might well overlap, particularly in view of the present Pugh status.
>
> "It seems that we mutually can expect every advantage from resuming the discussion to some mutually satisfactory conclusion so that each of us may aggressively pursue our endeavors without concern."

After further negotiations, the parties entered into an agreement as of September 26, 1944, whereby Ransburg granted to Behr-Manning an exclusive royalty-free license with right to sublicense under Ransburg's listed patents and applications, limited in substance to abrasive, flock-coated, and fiber-coated articles; and Behr-Manning granted to Ransburg a similar license under the listed Behr-Manning patents and applications, for use in "electrostatic propulsion, dispersion, orientation, deposition," etc., of liquid particles, except as to the aforesaid abrasive, flock-coated, and fiber-coated articles. Such patent rights as the Ransburg partnership received pursuant to this agreement were not directed to airless electrostatic spray painting or coating, and no rights were granted by Ransburg to Behr-Manning under the Starkey, et al application of September 19, 1944, which resulted in the patents here in suit. On January 1, 1948, defendant succeeded to the rights of the partnership under the agreement. Said Smyser reissue patent expired on January 13, 1948.

75. Prior to the execution of said agreement of September 26, 1944, Behr-Manning was not engaged in the business of marketing electrostatic spray-painting systems of either the air or airless type; had done no development work in that field; and in fact was excluded therefrom by the Harold P. Ransburg et al patents 2,247,963 and 2,334,648, and by Pugh patent 1,855,869. Neither has defendant or its predecessor at any time made or marketed abrasives or flock-coated articles. The agreement, having been executed at a time when Behr-Manning was already excluded from said field by Ransburg's patents, did not as a matter of fact exclude or remove Behr-Manning from said field as an existing or potential competitor of Ransburg. After the execution of the agreement, defendant received two inquiries as to the use of electrostatic processes for manufacture of abrasive, flock, or fiber products.

and in each instance the inquirer was informed that defendant's interest was in the painting field and that perhaps Behr-Manning could assist the inquirer. There is no evidence of any agreement, understanding, or arrangement between Behr-Manning and defendant except as set forth in said written agreement. The sole intent and purpose of the partnership in executing said agreement, and of defendant in succeeding to it, was to permit the marketing of its air-type No. 1 Process free from the possible risk of claims or suits for infringement of the listed Behr-Manning patents. The agreement in no way prohibited either party from later entering the field theretofore engaged in by the other, except insofar as the patents which were the subject of the agreement would have prevented such entry.

76. Among the patents under which the Behr-Manning agreement purported to give the Ransburg partnership a license were Winternute patent 2,221,338 and Meston patent 2,097,233. After the execution of the agreement, in marketing its No. 1 Process, the partnership gave assurances to some of its prospective licensees that it had an exclusive license under said patents, and license agreements were thereafter consummated. In early 1948, defendant learned that, at the time of the execution of the agreement with Behr-Manning, the latter did not in fact have the right to grant Ransburg a license under said two patents, and that such right was owned by Research Corporation. Thereafter on October 7, 1948, defendant executed an agreement with Research Corporation whereby, in consideration of the payment of royalties, defendant obtained an exclusive license under said two patents, with the proviso that, at any time after June 30, 1951, either party could convert the license to a non-exclusive one. By written notice dated May 26, 1954, defendant exercised this right and so converted the license. The Meston patent

expired on October 26, 1954, and the Wintermute patent expired on November 12, 1957. The intent and purpose of defendant in executing said agreement was to protect itself and its licensees against the possible risk of claims or suits for infringement of said patents.

77. The only patent related to the airless No. 2 Process which defendant has acquired from any person other than its own personnel is Simmons patent 2,808,343, which was assigned to defendant on March 5, 1952, by C. C. Simmons, President of Enameled Steel & Sign Company, Chicago, Illinois, pursuant to the terms of a pre-existing agreement between defendant and said company dated March 21, 1949. Approximately two years before defendant commenced the general marketing of its No. 2 Process, it entered into an arrangement with the above company whereunder defendant disclosed confidential engineering and development data on the process and Simmons' company performed research and development work with the process for defendant essentially as a consultant during the course of which it used the process in its own commercial coating of acoustical pans. As a part of this arrangement, the parties entered into the aforesaid written agreement, terminable upon thirty days' notice by either party at any time, licensing Simmons' company, upon favorable terms, to use the process, and providing that the user would treat all information relating to the process as secret and confidential; would disclose to defendant all techniques, knowledge, and information relating to inventions or improvements upon electrostatic coating process or apparatus; and would assign to defendant any invention, improvements, or letters patent relating thereto.

78. None of the aforesaid agreements pursuant to which defendant acquired patents or patent right was entered into by defendant or its predecessor with the purpose or

intent of restricting entry of competitors into the field of electrostatic spray-coating equipment, or of coercing the trade into dealing with defendant, and there is no evidence that any of them had such effect.

79. Plaintiff has at no time attempted to secure from anyone a license under any of the patents assigned or licensed to defendant pursuant to any of the aforesaid agreements, nor did plaintiff know of the existence of any of said agreements until after the commencement of this action and discovery depositions herein. None of said agreements, or any right acquired by defendant thereunder, affected plaintiff in any way.

80. Except for replacing defective parts, defendant does not contract to service or maintain the equipment used by its licensees and the licensees are free to perform such service and maintenance themselves, or obtain them from any source they desire. Plaintiff has at no time attempted to engage in the business of servicing electrostatic spray-coating equipment or dealing in used equipment or in replacement parts.

81. Defendant has no monopoly in the marketing of compressed-air electrostatic spray-coating systems. Such systems are, or have been marketed in competition with its No. 1 and No. 2 Processes by the following, some of whom have been so engaged since 1950 or 1951:

Ashdee Electrostatic Products, Inc.
Homewood, Illinois

Scientific Electric Co.
Garfield, New Jersey

Ionic Electrostatic Corp.
Garfield, New Jersey

H. G. Fischer Co.
Franklin Park, Illinois

Staticote Systems, Inc.
Chicago, Illinois

Plaintiff felt that it was free to enter this field at any time, but chose not to do so until 1958.

82. Defendant dominates the marketing in the United States of airless electrostatic spray-coating systems by virtue of the monopoly created by its patents. The defendant has never extended or enlarged said patent monopoly beyond its proper scope. Neither has the defendant a monopoly in any articles of commerce, except the atomizing heads which were specially designed for and have no other use than in defendant's airless electrostatic process.

83. Any article which can be coated by an airless electrostatic system can be coated by means of a compressed-air electrostatic system or by non-electrostatic compressed-air guns, operated manually or automatically, the major advantage of the airless electrostatic system over the others, being economic. In painting many articles of manufacture, airless electrostatic, air-type electrostatic, non-electrostatic air-spray systems, flow-coating, roller-coating or dipping, can and are substituted one for the other and are competitive. In the year 1957, the total cost of all paint, varnish and lacquer used industrially in the United States was $643,889,000. The total cost of all paint, varnish and lacquer used in that year in defendant's No. 2 Process equipment by its licensees was $6,693,642, or approximately 1% of the total, and the total cost of such material used in that year in air-type electrostatic equipment under defendant's licenses was $3,725,857, or approximately 0.6 of the aforesaid total.

84. Since its incorporation, defendant has employed a total of approximately 45 versions of the equipment and non-equipment license forms for its coating processes, most revisions being minor in nature. So that defendant, and all of its licensees, might share in the use of any improvements developed by licensees who had the advantage of the use of the No. 2 Process in its early field experience,

the forms employed from April, 1951, to January, 1955, to license its use included a requirement in substance that the licensee grant back to defendant a royalty-free, non-assignable, non-exclusive license, with right to sublicense, under any patents, inventions, or improvements acquired by licensee during the term of the agreement, and within two years thereafter, relating to air-less electrostatic coating methods and/or apparatus. Some of said license agreements are still in effect, but said grant-back clause has not been included in defendant's forms since January, 1955. Defendant has never acquired any patent or patent right pursuant to said clause in said agreement forms. Said clause has not stifled or discouraged research or invention by licensees.

85. The defendant has never leased equipment to any person upon the condition, agreement, or understanding that the lessee should not use or deal in the equipment of a competitor or competitors of the defendant.

86. In granting licenses under its patents, including the patents in suit, defendant impliedly represents to the trade and in interstate commerce, that it is the exclusive owner of the inventions covered by its patents. The defendant never represents that it exclusively owns any other or greater monopoly.

87. For the purpose of enabling manufacturers of paint and other coating materials to adapt their products for use in defendant's systems, defendant has granted to several of such manufacturers licenses to use the processes upon uniform terms which differ from those of defendant's standard forms, the principal difference being that the initial fee is lower and no monthly fees are payable. These licenses are for experimental and development work in paint formulation, and are not for production-line finishing. On occasion, one or more of such paint manufacturers has advertised that its product is suitable for use in de-

fendant's process. Such advertising has not been solicited by defendant and is not a condition of any of the aforesaid licenses. None of said licenses, or any of said advertising, has damaged plaintiff in any way.

88. The defendant has never conspired with anyone to restrain trade, or to create a monopoly, or to commit any act of unfair competition to plaintiff's damage.

89. The defendant's program or method of licensing the use of its processes or leasing its equipment, or any of its policies related thereto, considered individually or collectively, has not had the effect of enlarging or extending its patent monopoly beyond the scope contemplated by said patents.

90. The issuance and existence of the Starkey-Ransburg method patent 2,685,536, and the failure of plaintiff to obtain a license thereunder to make and sell equipment for the practice of the patented process on terms preferred by plaintiff, rather than any unlawful business practice of the defendant, prevented the only attempted sale by plaintiff of its SK661 emitter and related equipment, and caused plaintiff to desist from further sales efforts.

Alleged Knowledge by Defendant of Relevant Prior Art and Withholding Thereof from Patent Office Concerning the Defendant's Patents in Issue.

91. The defendant, during prosecution of the applications which resulted in the patents in suit, made no material negligent or willful misrepresentations of the Patent Office or withheld from the Patent Office knowledge of pertinent prior art. Defendant did not have knowledge of any prior art more pertinent than the Darrah patent, and that patent was known to the Patent Office.

92. The defendant did not fail to disclaim claims of the patents in issue that were covered by anticipated prior art.

93. The defendant in prosecuting the applications voluntarily cancelled some claims in the applications which issued as the patents in issue but the defendant in no way expressly or impliedly cancelled the remaining claims and particularly claim four in issue which covers plaintiff's emitter.

94. It is unnecessary to find the facts pertinent to defendant's second defense to the plaintiff's cross-counterclaim in view of the findings set forth above and the following conclusions of law.

Conclusions of Law

Upon the foregoing findings the Court concludes the law to be as follows:

1. The Court has jurisdiction of the parties and subject matter of the issues of defendant's counterclaim and supplemental counterclaim and plaintiff's defenses thereto; and of plaintiff's cross-counterclaim and defendant's defenses thereto.

2. The defendant has maintained its burden of proof of the essential facts of defendant's counterclaim and supplemental counterclaim. The plaintiff has not maintained the burden of proof of the essential facts of any one of plaintiff's affirmative defenses to defendant's counterclaim and/or supplemental counterclaim. The law is with the defendant and against the plaintiff on each of the issues of defendant's counterclaim and supplemental counterclaim and plaintiff's defenses thereto.

3. The plaintiff has not maintained the burden of proof of the essential facts of plaintiff's cross-counterclaim. The law is with the defendant and against the plaintiff on each of the issues of plaintiff's cross-counterclaim and defendant's first defense thereto.

4. It is unnecessary to and the Court does not conclude

on the defendant's second defense to the plaintiff's cross-counterclaim in view of these findings and conclusions?"

5. United States Letters Patent No. 2,685,536, entitled "Method for Electrostatically Coating Articles," as to claims 1 to 6, 8, 10, and 11 here in suit, is in all respects valid."

6. Plaintiff has infringed the aforesaid patent by using and practicing the method or process thereof.

7. United States Letters Patent No. 2,794,417, entitled "Apparatus for Electrostatically Coating Articles," as to claim 4, here in suit, is in all respects valid.

8. Plaintiff has infringed the aforesaid patent by making and using the apparatus thereof.

9. Defendant is entitled to: (a) an injunction against the plaintiff enjoining further infringement, direct or contributory of each of the patents described in conclusions 5 and 9, and (b) a judgment for damages as provided by Title 35, U. S. C., Sections 284-285, including reasonable attorneys' fees, costs, and interest, and for an accounting to ascertain the amount thereof for such infringement of each of the patents described in conclusions 5 and 9 and the cause is continued as to these issues pursuant to the stipulation of the parties and Rule 42(b) of the Federal Rules of Civil Procedure.

10. The defendant is entitled to judgment on said cross-counterclaim; and to recover its costs from the plaintiff.

11. Every finding of fact deemed a conclusion of law is hereby adopted as a conclusion of law.

Dated this 16 day of June, 1959.

Cale J. Holder,
Judge, United States District Court,
Southern District of Indiana.

UNITED STATES DISTRICT COURT,
(Caption—56-C-262)

ENTRY.

The Court, having filed herein its Findings of Fact and Conclusions of Law on June 16, 1959, and it appearing that there are certain typographical errors in Conclusion of Law No. 9, said Conclusion of Law is hereby amended upon the Court's own motion to read as follows:

> "9. Defendant is entitled to: (a) an injunction against the plaintiff enjoining further infringement, direct or contributory, of each of the patents described in conclusions 5 and 7, and (b) a judgment for damages as provided by Title 35, U. S. C., Sections 284-285, including reasonable attorneys' fees, costs, and interest, and for an accounting to ascertain the amount thereof for such infringement of each of the patents described in conclusions 5 and 7 and the cause is continued as to these issues pursuant to the stipulation of the parties and Rule 42(b) of the Federal Rules of Civil Procedure."

Dated this 18 day of June, 1959.

Cale J. Holder,
Judge, United States District Court, Southern District of Indiana.

UNITED STATES DISTRICT COURT.

(Caption—56-C-262)

JUDGMENT.

This cause having been submitted to the Court for trial of all issues except damages and attorneys' fees, pursuant to Rule 42(b) of the Federal Rules of Civil Procedure, without intervention of a jury, and the parties having submitted their proposed special findings of fact, conclusions of law thereon, judgment entries, and post-trial briefs, and having exchanged their trial briefs, in accordance with the entry herein of January 8, 1959; the Court having considered the pleadings, the opening statements of counsel, the evidence received at the trial, the proposed special findings of fact, conclusions of law, judgment entries, briefs, and arguments of counsel, and having filed herein on June 16, 1959, its Special Findings of Fact and Conclusions of Law pursuant to Rule 52 of the Federal Rules of Civil Procedure.

Upon the aforesaid Special Findings of Fact and Conclusions of Law, It Is Hereby Adjudged And Decreed:

1. That United States Letters Patent No. 2,685,536, entitled "Method for Electrostatically Coating Articles," as to claims 1 to 6, 8, 10, and 11, is in all respects valid.

2. That Plaintiff has infringed the aforesaid patent by using and practicing the method or process thereof.

3. That United States Letters Patent No. 2,794,417, entitled "Apparatus for Electrostatically Coating Articles," as to claim 4, is in all respects valid.

4. That Plaintiff has infringed the aforesaid patent by making and using the apparatus thereof.

5. That the Plaintiff, including its officers, agents, servants, employees, and associates, and each of them, is enjoined from:

(a) Using the method or process employing the invention covered by claims 1 to 6, 8, 10, and 11 of United States Letters Patent No. 2,685,536, or inducing or contributing to the use of said method or process, during the life of said patent; and

(b) Making, using, or selling the device described in this cause as the SK-661 emitter for use in an apparatus or system for electrostatically coating articles and from making, using, or selling any other devices, equipment, or apparatus for electrostatically coating articles embodying the invention covered by Claim 4 of United States Letters Patent No. 2,794,417, and from inducing or contributing to the infringement of said claim, during the life of said patent; and

(c) Otherwise infringing, directly or contributorily, the aforesaid claims of said patents.

6. That the Defendant recover from the Plaintiff damages for infringement of United States Letters Patent No. 2,685,536 and No. 2,794,417, pursuant to Title 35, U. S. C., Sections 284-285, together with reasonable attorneys' fees and costs, by reason of the making and using in the United States since the respective dates of issue of the aforesaid patents, the aforesaid SK-661 emitter and the apparatus of which it is a part for electrostatically coating articles; and the cause is continued as to these issues pursuant to the stipulation of the parties and Rule 42(b) of the Federal Rules of Civil Procedure.

7. That the Plaintiff's cross-counterclaim is hereby dismissed and that Defendant recover its costs thereon.

Dated this 18 day of June, 1959.

Cale J. Holder,
Judge, United States District Court, Southern District of Indiana.

IN THE UNITED STATES DISTRICT COURT
For the Southern District of Indiana,
Indianapolis Division.

Binks Manufacturing Company, (a corporation of the State of Delaware), *Plaintiff,*	Civil Action No. IP 56-C-262.
vs.	
Ransburg Electro-Coating Corp., (a corporation of the State of Indana), *Defendant.*	

NOTICE OF APPEAL.

Notice is hereby given that Binks Manufacturing Company, plaintiff in Civil Action No. IP 56-C-262, hereby appeals to the United States Court of Appeals for the Seventh Circuit from all of the Judgment entered in said action on June 18, 1959.

Harold B. Hood,
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Indianapolis 4, Indiana,

Charles F. Meroni,
Otto R. Krause,
Hill, Sherman, Meroni, Gross & Simpson,
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Attorneys for Appellant, Binks Manufacturing Company.

UNITED STATES DISTRICT COURT.
(Caption—56-C-262)

ENTRY JULY 30, 1959.

This cause came before the Court on Plaintiff's Petition for an extension of time within which to file and docket record on appeal. The Court having considered said petition and being duly advised in the premises, now Grants the same, and

Orders that the time for filing said record on appeal be extended to and including September 30, 1959.

Cale J. Holder,
United States District Judge.

1021

Aug. 3, 1954 W. A. STARKEY ET AL 2,685,536

METHOD FOR ELECTROSTATICALLY COATING ARTICLES

Filed Sept. 29, 1944 2 Sheets-Sheet 1

FIG. 1

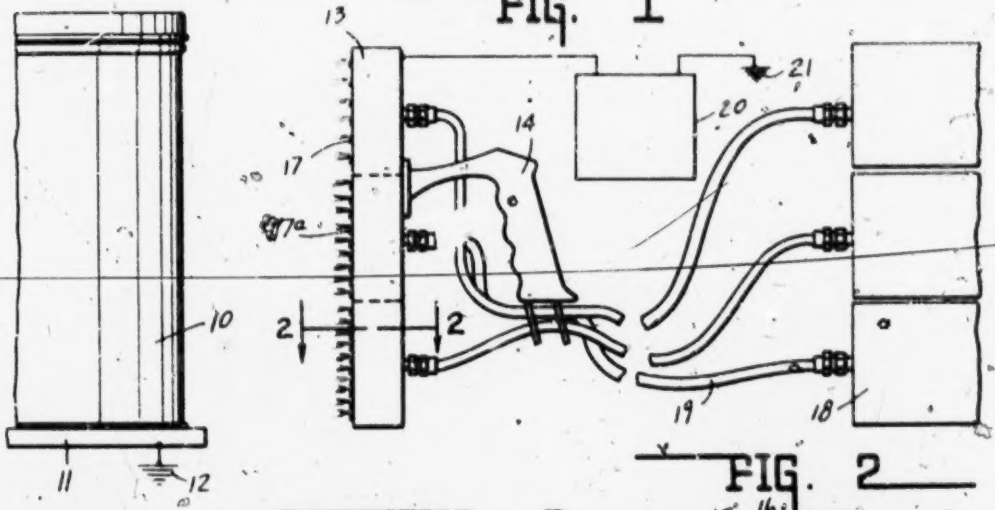


FIG. 2

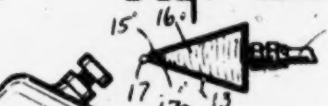


FIG. 3

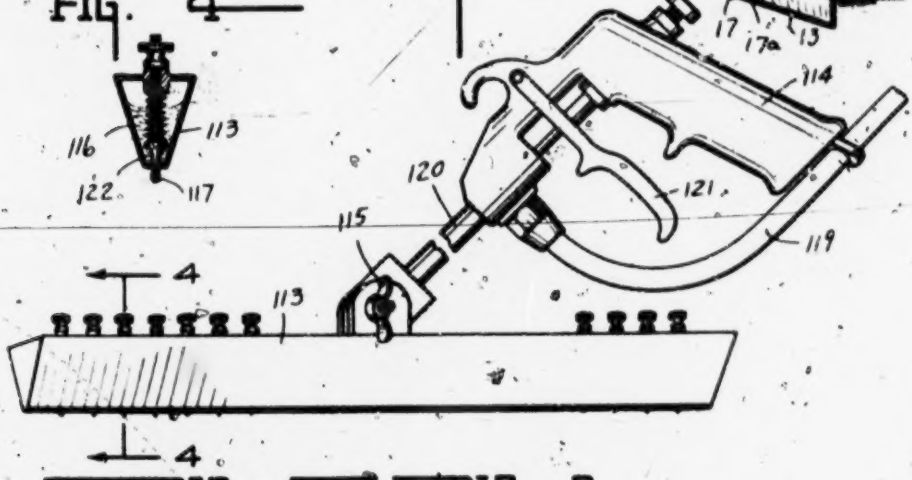


FIG. 4

FIG. 5

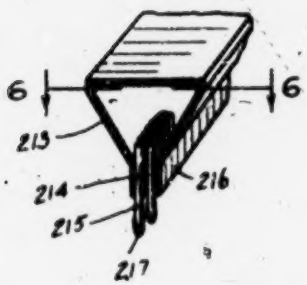
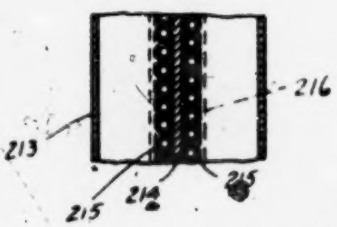


FIG. 6



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Aug. 3, 1954 W. A. STARKEY ET AL 2,685,536

METHOD FOR ELECTROSTATICALLY COATING ARTICLES

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FIG. 7

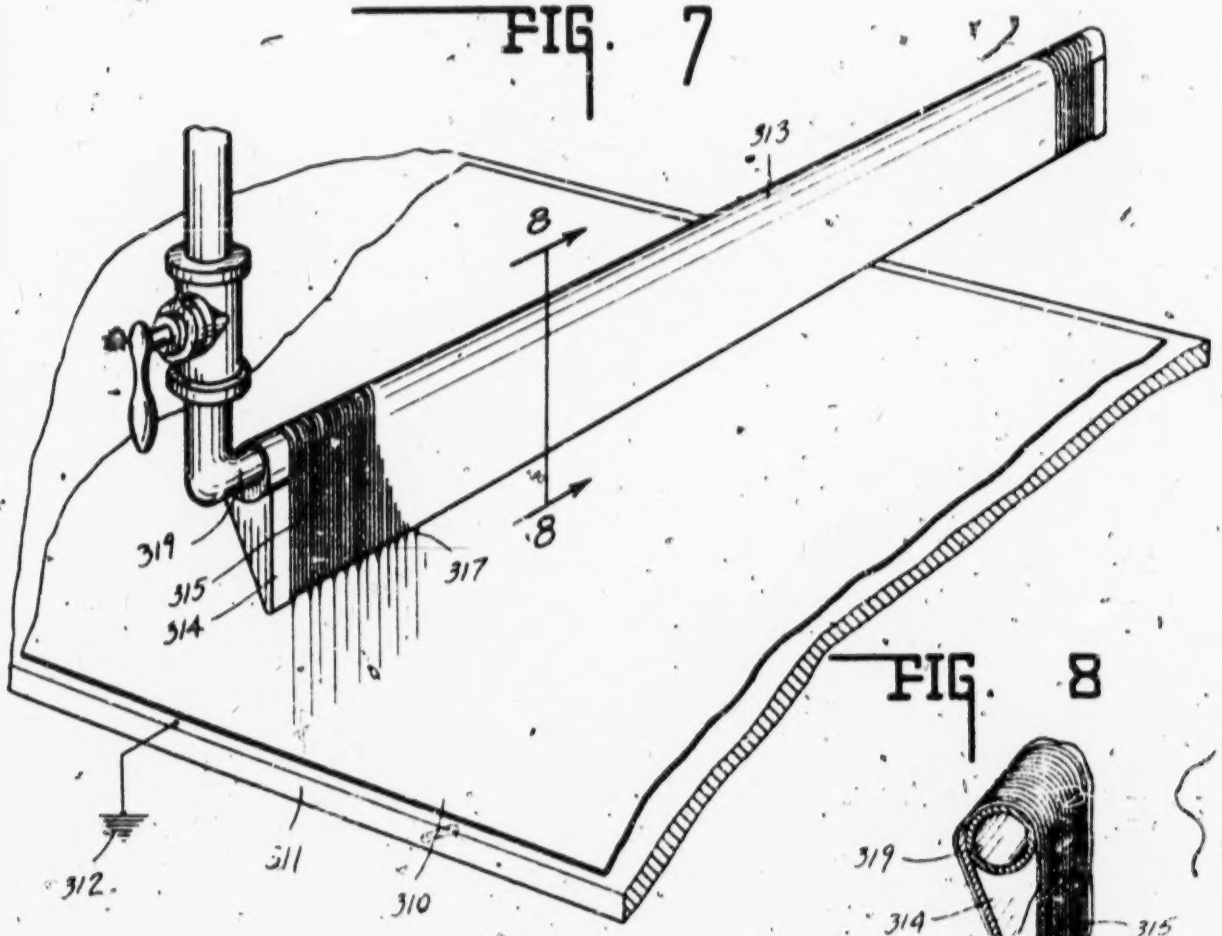


FIG. 8

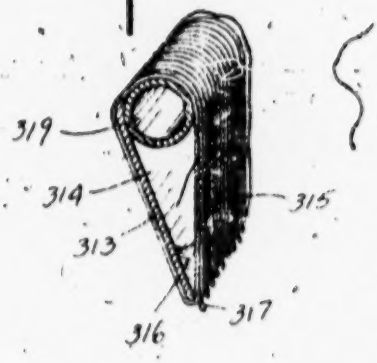
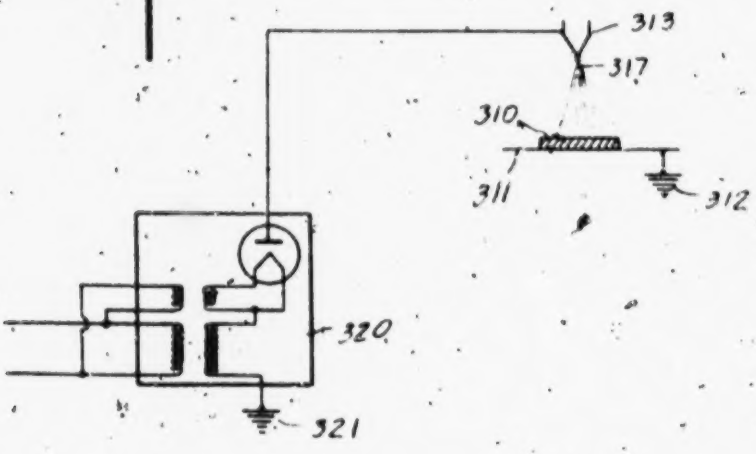


FIG. 9



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UNITED STATES PATENT OFFICE

2,685,536

METHOD FOR ELECTROSTATICALLY COATING ARTICLES

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Application September 29, 1944, Serial No. 556,390

11 Claims. (Cl. 117—93)

1

This invention relates to a method and apparatus for electrostatically coating articles with a liquid coating material, such as paint, lacquer, ink, wax and the like. Such articles to be coated may be of either conducting or non-conducting material, may be structural in character or comprise fabric or paper sheets.

In respect to the method of electrostatically coating articles by discharging a spray of coating material from an air operated or air atomizing spray gun reference may be made to such prior patents as Pugh, No. 1,855,859, issued April 26, 1932, for "Method and Apparatus for Coating Articles," and Ransburg and Green, Nos. 2,247,963 and 2,334,648, issued July 1, 1941, and November 16, 1943, for "Apparatus for Spray Coating Articles" and "Method of Spray Coating Articles," respectively.

However, in the use of spray guns or the like many disadvantages develop in that the air operated spray gun is limited to a comparatively small field of dispersion, but more important it causes the coating material to be discharged in non-uniform sized particles, and in variable patterns. Thus, there is an uneven dispersion of the coating particles over the surface to be coated due to the inertia generated in the discharge, causing the larger particles to travel further in the field than the more finely divided particles. In some arrangements, depending upon the direction of the discharge, a variable pattern of spray is created and reproduced on the surface to be coated, the heavier coating particles being caused to impinge over one area and the more finely divided particles over another area. By reason of such variance, it has been found necessary in practice under certain conditions of coating to arrange a sizeable battery of spray guns with particular regard to their variable patterns of coating application so that the several guns complement each other to even out the pattern as a battery.

It is the purpose of this invention to meet this problem of coating articles in an electrostatic field by eliminating the use of such spray guns and employ in place thereof a new method and apparatus for supplying the coating material for electrostatic precipitation upon the surface to be coated. This is accomplished by providing in the field a series or plurality of small inert droplets of coating material and establishing such electrostatic force in the field as to develop and transmit finely divided particles of coating material from said droplets to the surface of the article to be coated. In describing as "inert"

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the drops or droplets from which atomization takes place, it is our purpose to indicate that during the coating process each drop is supported on the head as above described, and that while the drop may be continuously giving off liquid for atomization, replacement enables its identity as a supported body of liquid to be maintained.

Such method and apparatus has several important advantages over the spray gun arrangements heretofore employed. The coating material may be introduced into the electrostatic field by an applicator head having a series of orifices through which the material may ooze in the form of inert droplets. Such applicator head may be substantially coextensive with the surface to be coated and thereby take the place of a battery of spray guns as heretofore employed. The droplets will be developed into finely divided particles by the electrostatic force so that all particles will be transmitted or precipitated upon the surface to be coated uniformly over the entire surface.

A feature of the invention, as above described, resides in the applicator head including formation of the discharge orifices therein and the control of the rate of discharge of the material to form the inert droplets at approximately the rate of their electrostatic discharge. Thus, depending upon the viscosity and other characteristics of the material, the control of the applicator head will be such as to permit discharge of just the right quantity and size of the droplets to effect the greatest efficiency in coating a surface.

The full nature of the invention will be understood from the accompanying drawings and the following description and claims:

Fig. 1 is a diagrammatical illustration showing one arrangement of applicator in respect to the article to be coated. Fig. 2 is a section taken on the line 2—2 of Fig. 1. Fig. 3 is a perspective view of a modified form of applicator with a control handle associated therewith. Fig. 4 is a section taken on the line 4—4 of Fig. 3. Fig. 5 is a perspective sectional view showing a portion of a further modification of the applicator head. Fig. 6 is the same as Fig. 5, taken on the line 6—6 thereof. Fig. 7 is a perspective view of a further modification of the applicator head in association with the surface to be coated. Fig. 8 is a section taken on the line 8—8 of Fig. 7. Fig. 9 is a diagrammatical illustration of the circuit and one of the arrangements of the applicator head relative to the article to be coated.

The invention is illustrated by one modification

thereof in Figs. 1 and 2 wherein there is shown an article 10 to be coated mounted or carried upon a suitable support or conveyor 11 which is grounded at 12. An applicator head 13 is provided which is preferably substantially co-extensive with the surface to be coated. Said applicator head may be fixedly or adjustably mounted on a suitable support, or hand manipulated by a handle 14. The applicator head, as indicated in Fig. 2, is V-shape in cross section and along its reduced discharge edge 17a it is provided with a series of orifices 15 through which the coating material indicated at 16 may be oozed out in the form of droplets 17. The applicator head may be connected with a source of supply of coating material by a flexible tube, there being herein illustrated three compartments in the head, each connected with an individual source of supply 18 by a tube 19. The discharge edge 17a has an extent many times the maximum cross-sectional dimension of the passageways provided by the tubes 19. Sufficient pressure will be created in the containers forming the source of supply 18 for maintaining the material 16 in the head under just the proper pressure to cause the droplets to ooze therefrom as they are dispersed by the applied electrostatic force.

As illustrated, the applicator head is connected to a source of high voltage indicated at 20 through one terminal thereof, the other terminal of said source being grounded at 21 and through ground connected with an article 10 to be coated. Accordingly, the space or field between the applicator head and articel 10 is electrostatically charged by reason of the article being grounded and the applicator head being at high potential. The effect thereof is to cause an electrical force to act on the droplets 17, causing them to be broken up into finely divided or minute particles of coating material, such as to be attracted to the grounded article for deposition thereon. Thus, the grounded article may be referred to as a collecting electrode of one potential with the applicator head serving as a discharge electrode of a different potential. It is found that the electrostatic force set up in the field between the electrodes is such as to develop and transmit finely divided particles of the droplets 17 from one electrode to the other. In this connection it will be noted that as the droplets are caused to slowly ooze from the applicator head they are inactive or inert, but subject to being broken up into finely divided particles and distributed over the surface of the opposed electrode. The same action will take place wherein the applicator head may be grounded and the article directly connected with the source of high voltage and thus be charged at a high potential.

Another modification is illustrated in Figs. 3 and 4, wherein the applicator head 113 is adjustably supported by the handle 114 through a pivotal connection secured by thumb nut 115. The hose 119 leading from a source of coating material maintained under pressure, is connected with a valve operated conduit 120 controlled by the finger operated valve 121. Also, the droplets of coating material 117 may be controlled, depending upon the viscosity of the material indicated at 116 by a needle adjustment 122, which needle adjustably controls the orifice through which the material 116 is forced to provide the desired inert droplets.

Figs. 5 and 6 show a further modification of the applicator head indicated at 213. In this head the orifices through which the coating material flows are provided by a plate 214 clamped between opposed rows of needles 215. The needles are cylindrical so that the material will be caused to flow between them, the plate 214 and the clamping walls 216 so as to come out in the form of an inert droplet 217 of coating material.

In the modification of Figs. 7 and 8 there is illustrated a grounded surface 310 to be coated. This may be a continuously moving sheet of paper or any other article, it being understood that wherein such article or material is non-conducting, it is carried by and on a support or conveyor 311 of grounded conducting material. In this arrangement the applicator head 313 is supported across and above the surface to be coated, and coating material is fed thereto through the valve controlled pipe 314 leading from the source of such material. Said pipe extends through the head, having a series of orifices or openings therein through which the material may drip by gravity. Mounted on and connected to a source of high voltage through the pipe 319, there is a supporting shield 317 extending downwardly and terminating below the pipe to provide a frame for a wire wrapping 315. The coating material accumulates from the drippings into a pocket formed by the wire wrappings, as indicated at 316. The wire wrappings are slightly or sufficiently spaced to permit the coating material to slowly ooze or drip therebetween from the accumulation in the pocket indicated at 316 to form the droplets 317. In this instance the discharge or oozing of the material from the applicator head is aided by gravity, the droplets being thereupon broken up or developed into finely divided particles by the electrostatic force developed between the applicator head and the surface to be coated. Such finely divided particles will thereupon be dispersed by the electrostatic force over said surface and be applied to said surface. The applicator head can be grounded and the work maintained at high potential with equally efficient results.

By way of example, the arrangement of the overhead applicator of Fig. 7 is shown diagrammatically in Fig. 9, wherein the source of high voltage indicated at 320 has one terminal grounded at 321 and the other terminal connected with the applicator head 313 which is thereby maintained at high potential relative to the support or conveyor 311, which is connected with ground at 312.

As above pointed out, it is immaterial as to whether the article or the applicator head comprises the grounded electrode, since the electrostatic force set up therebetween will have the same effect on the droplets of coating material. Also, it is immaterial as to whether or not the article to be coated is of conducting or non-conducting material, and such article of non-conducting material is herein considered to be one of the electrodes wherein it is associated with or masks a grounded support of conducting material.

The invention claimed is:

1. A method of electrostatically distributing liquid as a coating on an article, comprising the steps of supporting liquid coating material in spaced relation to the surface of the article forming a spray by electrostatically atomizing such coating material from a plurality of points so closely spaced as to form a substantially continuous extended atomizing zone, said points being distributed relative to the article surface electrostatically dispersing the discrete coating

...erial particles formed at each point of atomi... electrostatically depositing such dispersed ...crete particles and while still in liquid state ...the article surface to form a finished coating, ...force feeding coating material to the points ...omization at a controlled substantially uni... rate to maintain thereat a supply of coating ...erial for atomization, said atomization, dis...on and deposition all being effected in quies... air by a single electrostatic field maintained ...ween the supported coating material and the ...cle surface, the distance between the article ...face and the supported coating material being ...ay times greater than the distance between ...acent ones of the points at which atomization ...the coating material takes place.

...In a method of electrostatically distributing ...id as a coating on a surface wherein liquid ...lied at a controlled rate to a single-fluid ...izing head is atomized into discrete particles ...such particles are dispersed to form a spray ...deposited in dispersed condition while still ...liquid state as a finished coating on a surface ...ed a substantial distance from the head, the ...g of maintaining between the head and the ...icle an electrostatic field which electrostati... effects said atomization, dispersion, and ...osition.

...A method of electrostatically distributing ...id as a coating on an article, comprising the ...s of positioning a body of the liquid at an ...izing zone in spaced relation to the article, ...izing discrete particles of the liquid as a ...ay from said body at said zone, force feeding ...e body with liquid at a controlled rate to re... ...face that so atomised, and dispersing said par...cles widely in at least two mutually perpen...icular directions and electrostatically depositing ...em still so dispersed and as discrete spray... ...articles while still in liquid state as a finished ...ating on the article, the movement of the spray ...articles being through a quiescent atmosphere ...hereby the electrostatic forces effect deposition ...n an adjacent article surface of at least a major... ...y of the spray particles which would have other...wise not deposited on the article surface, the dis...ance between the article and the atomizing zone ...eing great enough to permit said dispersion of ...the finely divided liquid spray particles as they ...proceed toward the article under the influence of ...electrostatic forces.

4. A method of electrostatically distributing liquid as a coating on an article, comprising the steps of supplying liquid coating material at a controlled rate to an atomizing zone located in spaced relation to the article, establishing said liquid as an electrode of an electrostatic field, atomizing finely divided discrete spray particles from the liquid at the atomizing zone, and dispersing such particles widely in at least two mutually perpendicular directions and depositing them still so dispersed and while still in liquid state as discrete spray particles on the article to form a finished coating thereon, the distance between the atomizing zone and the article being great enough to permit said dispersion of the particles as they proceed toward the article, the atmosphere in the region between the atomizing zone and the article being quiescent whereby electrostatic forces will be the predominant factor determining the paths respectively followed by the atomized particles as they move toward deposition; and moving said article relative to said atomizing zone so as to effect a substantial displacement of the article surface transverse to the general direction of the lines of force of the field during particle deposition to cause such lines of force to sweep such article surface.

5. In a method of electrostatically distributing liquid as a coating on an article wherein liquid coating material supplied at a controlled rate to a single-fluid atomizing head is force fed to and atomized into discrete particles from a plurality of points so closely spaced as to form a substantially continuous atomizing zone and such particles are dispersed and deposited in dispersed condition and while still in liquid state on an article spaced from said atomizing zone, the step of maintaining between the head and the article an electrostatic field capable of electrostatically effecting atomization, dispersion, and deposition of the coating material, the distance between the head and article being equal to at least several times the distance between adjacent ones of the points at which said atomization occurs.

6. A method of electrostatically distributing liquid as a coating on an article, comprising the steps of supplying liquid at a controlled rate, forming the liquid into an extended film and causing the film to flow toward an atomizing zone, atomizing finely divided, discrete particles of liquid at a plurality of closely spaced aligned points at said atomizing zone, and electrostatically dispersing such particles and depositing them on the article as a spray while still in liquid state, the distance between the atomizing zone and the article being materially greater than the film will bridge and great enough to permit the dispersion of the particles as they proceed toward the article under the influence of electrostatic forces.

7. The method of electrostatically distributing liquid as a coating on an article, comprising the steps of supporting a body of liquid coating material in the form of a film having an exposed surface, the terminus of said film being spaced from said article, establishing between said article and the terminus of the film an electrostatic field of such strength as both to be capable of electrostatically atomizing finely-divided, discrete liquid spray particles from said terminus of the film and of electrostatically dispersing such particles and depositing them still as discrete spray particles and while still in liquid state upon the surface of said article to form a finished coating on the same, and continuously and at a controlled rate replenishing in said body the coating material atomized therefrom for deposition by the action of the electrostatic field, the gap between the said terminus of the film and the article being wide enough both to insure that it will not be bridged by the supported liquid coating material and to permit the atomized particles, before being deposited, to be dispersed and distributed over a substantial area.

8. The method of electrostatically distributing liquid as a coating on an article, comprising the steps of positioning a body of liquid coating material in opposed spaced relation to the article, said body having an exposed surface, causing said body to flow forwardly, establishing between the article and the liquid body an electrostatic field of sufficient strength both to electrostatically atomize finely divided, discrete liquid spray particles from a plurality of aligned points so closely spaced as to provide a substantially continuous extended atomizing zone along the terminus of the exposed surface nearest the article and to electrostatically disperse said particles

and to deposit them on the article still in the form of discrete spray particles while still in liquid state, and continuously and at a controlled substantially uniform rate adding additional liquid coating material to said body at a point spaced rearwardly from said terminus to maintain said flow, said terminus and the article being spaced apart by a distance great enough to permit the atomized spray particles, before being deposited, to be dispersed and distributed as discrete spray particles over a substantial area.

9. The method of electrostatically distributing liquid coating material as a coating on an article, comprising the steps of causing the liquid to flow in a continuous stream and at a positively regulated rate to a point of atomization where such stream has an exposed surface, positioning the point of atomization opposite to and spaced from the article to be coated, establishing between the article and the exposed surface of the stream an electrostatic field, and with the aid of said field atomizing discrete particles from said exposed surface, dispersing such discrete particles, moving them through quiescent air and depositing them as a liquid spray on an adjacent article surface to form a finished coating thereon, the distance between the point of atomization and the article being greater than the stream will bridge and great enough that the deposited particles will be distributed over an area having each of its dimensions many times greater than the minimum cross-sectional dimension of the stream at the point of atomization.

10. The method of electrostatically distributing liquid as a coating on an article, comprising the steps of moving the article past and in spaced relation to a zone of atomization, feeding liquid coating material in a relatively narrow stream, spreading said stream to form it into a body of liquid coating material having an extent many times the maximum cross-sectional dimension of said stream, maintaining at such zone of atomization the body of liquid coating material with said body having a plurality of closely spaced aligned exposed termini of relatively small area, establishing between the exposed termini of the coating material and the article moving past it an electrostatic field of sufficient strength that it both electrostatically atomizes small particles of coating material from such exposed termini and electrostatically deposits them still in the form of discrete spray particles while still in liquid state for distribution into a continuous finished coating upon the article as it moves past the zone of atomization, and continuously and at a controlled rate maintaining said stream to supply coating material to said body to replace the coating material atomized therefrom by the action of the electrostatic field, said atomization and deposition both being effected in quiescent air, the direction of movement of said article relative to said body of coating material being such as to effect a substantial displacement of the article surface transverse to the general direction of the lines of force of the field during particle deposition to cause such lines of force to sweep such article surface, the spacing of said body of coating material from the article being great enough that the atomized particles will disperse under the action of the field as they move toward the article until they are distributed over and deposited onto a portion of the article surface having an area many times the area of the opposed termini.

11. A method of electrostatically depositing liquid as a coating on an article, comprising the steps of supplying liquid as a film to an extended atomizing zone in spaced relation to the article, atomizing discrete particles of the liquid as a spray from said zone, force feeding the zone with liquid at a controlled rate to replace that atomized, dispersing said particles widely transversely and longitudinally of the extent of the atomizing zone, and creating an electrostatic charge differential between the particles and the article of a strength to move the particles toward the article sufficiently rapidly to deposit them thereon while still in liquid state and while still so dispersed, the movement of the spray particles being through a quiescent atmosphere wherein the electrostatic forces effect deposition on an adjacent article surface of spray particles which would have otherwise not deposited on the article surface, the distance between the article and the atomizing zone being great enough to permit said dispersion of the finely divided liquid spray particles as they proceed toward the article under the influence of electrostatic forces.

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June 4, 1957 W. A. STARKEY ET AL 2,794,417

APPARATUS FOR ELECTROSTATICALLY COATING ARTICLES

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FIG. 1

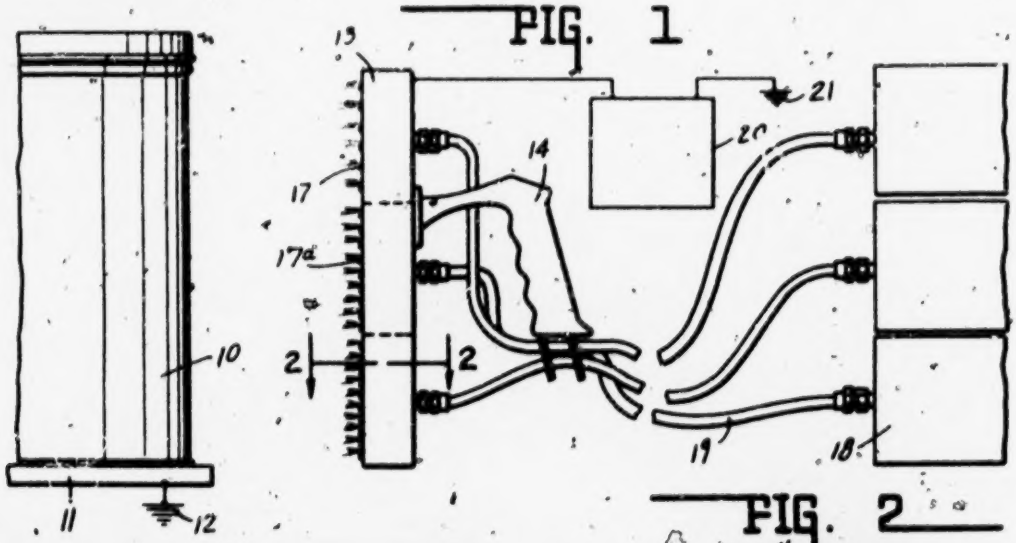


FIG. 2

FIG. 3

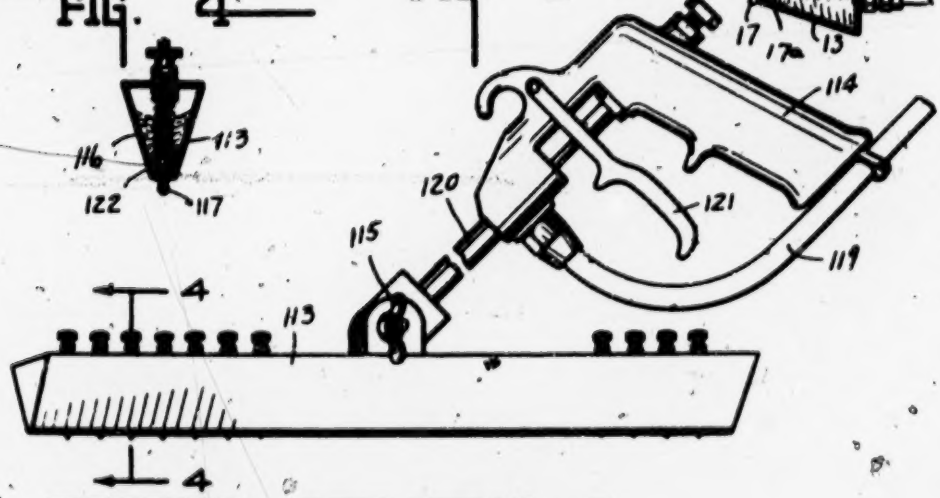


FIG. 4

FIG. 5

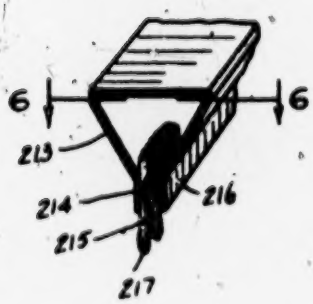
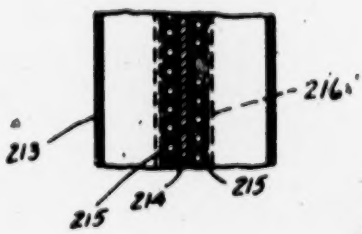


FIG. 6



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June 4, 1957 W. A. STARKEY ET AL 2,794,417

APPARATUS FOR ELECTROSTATICALLY COATING ARTICLES

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FIG. 7

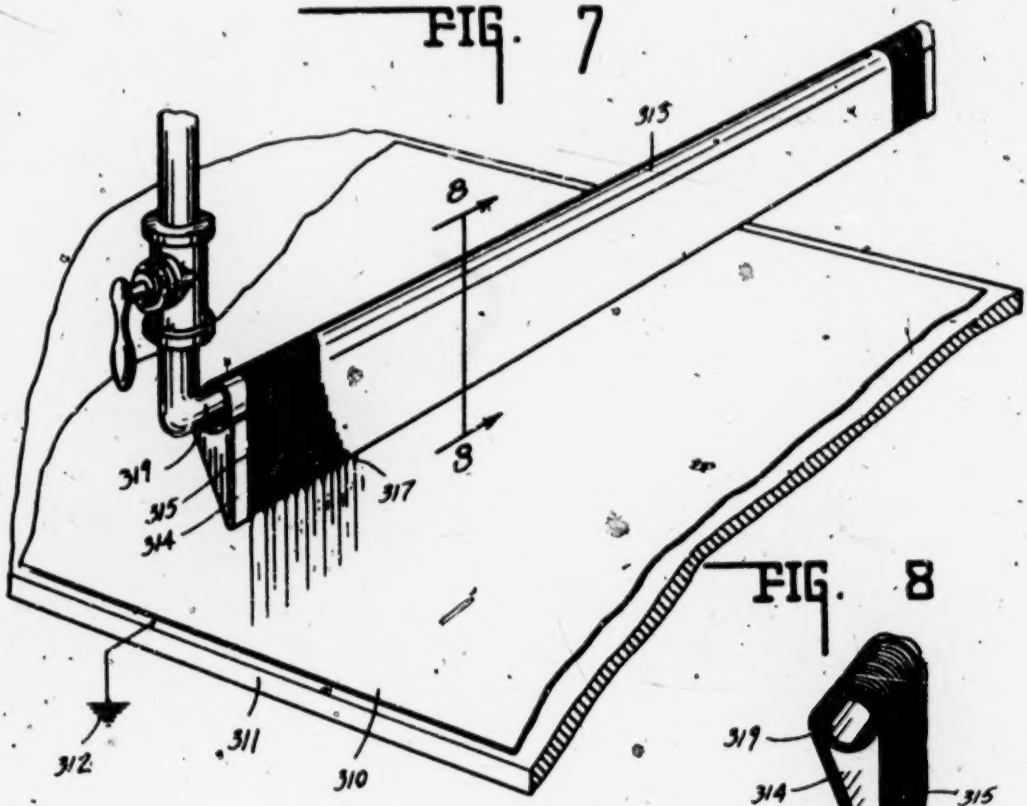
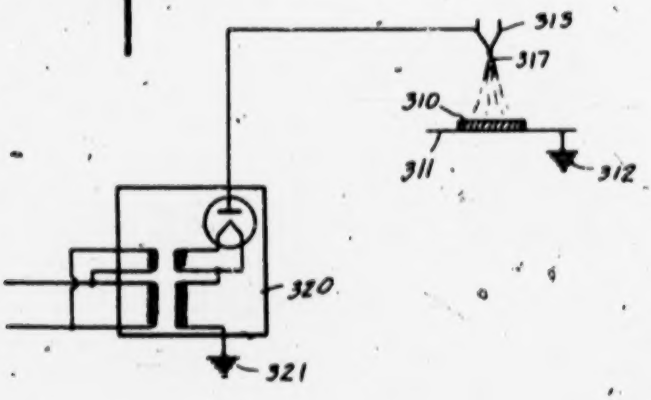


FIG. 8

FIG. 9



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United States Patent Office 1033 2,794,417
Patented June 4, 1957

2,794,417

APPARATUS FOR ELECTROSTATICALLY COATING ARTICLES

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Original application September 29, 1944, Serial No. 556,390, now Patent No. 2,685,536, dated August 3, 1954. Divided and this application June 4, 1954, Serial No. 434,366

4 Claims. (Cl. 118—51)

This application is a division of our copending application Serial No. 556,390, filed September 29, 1944, now Patent No. 2,685,536, granted August 3, 1954. That patent describes a method and apparatus for electrostatically coating articles with a liquid coating material such as paint, lacquer, ink, wax and the like. Such articles to be coated may be of either conducting or non-conducting material, may be structural in character or comprise fabric or paper sheets.

This application is particularly directed to forms of apparatus suitable for use in carrying out methods claimed in our aforesaid patent.

In respect to the method of electrostatically coating articles by discharging a spray of coating material from an air operated or air atomizing spray gun reference may be made to such prior patents as Pugh, No. 1,855,859, issued April 26, 1932, for "Method and Apparatus for Coating Articles," and Ransburg and Green, Nos. 2247,963 and 2,334,648, issued July 1, 1941, and November 16, 1943, for "Apparatus for Spray Coating Articles" and "Method of Spray Coating Articles," respectively.

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It is the purpose of our invention to meet this problem of coating articles in an electrostatic field by eliminating the use of such spray guns and employ in place thereof a new method and apparatus for supplying the coating material for electrostatic precipitation upon the surface to be coated. This is accomplished by providing in the field a series or plurality of small inert droplets of coating material and establishing such electrostatic force in the field as to develop and transmit finely divided particles of coating material from said droplets to the surface of the article to be coated. In describing as "inert" the drops or droplets from which atomization takes place, it is our purpose to indicate that during the coating process each drop is supported on the head as above described, and that while the drop may be continuously

giving off liquid for atomization, replacement enables its identity as a supported body of liquid to be maintained.

Such method and apparatus has several important advantages over the spray gun arrangements heretofore employed. The coating material may be introduced into the electrostatic field by an applicator head having a series of orifices through which the material may ooze in the form of inert droplets. Such applicator head may be substantially coextensive with the surface to be coated and thereby take the place of a battery of spray guns as heretofore employed. The droplets will be developed into finely divided particles by the electrostatic force so that all particles will be transmitted or precipitated upon the surface to be coated uniformly over the entire surface.

A feature of the invention, as above described, resides in the applicator head including formation of the discharge orifices therein and the control of the rate of discharge of the material to form the inert droplets at approximately the rate of their electrostatic discharge. Thus, depending upon the viscosity and other characteristics of the material, the control of the applicator head will be such as to permit discharge of just the right quantity and size of the droplets to effect the greatest efficiency in coating a surface.

The full nature of the invention will be understood from the accompanying drawings and the following description and claims.

Fig. 1 is a diagrammatical illustration showing one arrangement of applicator in respect to the article to be coated. Fig. 2 is a section taken on the line 2—2 of Fig. 1. Fig. 3 is a perspective view of a modified form of applicator with a control handle associated therewith. Fig. 4 is a section taken on the line 4—4 of Fig. 3. Fig. 5 is a perspective sectional view showing a portion of a further modification of the applicator head. Fig. 6 is the same as Fig. 5, taken on the line 6—6 thereof. Fig. 7 is a perspective view of a further modification of the applicator head in association with the surface to be coated. Fig. 8 is a section taken on the line 8—8 of Fig. 7. Fig. 9 is a diagrammatical illustration of the circuit and one of the arrangements of the applicator head relative to the article to be coated.

The invention is illustrated by one modification thereof in Figs. 1 and 2 wherein there is shown an article 10 to be coated mounted or carried upon a suitable support or conveyor 11 which is grounded at 12. An applicator head 13 is provided which is preferably substantially coextensive with the surface to be coated. Said applicator head may be fixedly or adjustably mounted on a suitable support, or hand manipulated by a handle 14. The applicator head, as indicated in Fig. 2, is V-shaped in cross section and along its reduced discharge end 17*a* it is provided with a series of orifices 15 through which the coating material indicated at 16 may be oozed out in the form of droplets 17. The applicator head may be connected with a source of supply of coating material by a flexible tube, there being herein illustrated three compartments in the head, each connected with an individual source of supply 18 by a tube 19. The discharge edge 17*a* has an extent many times the maximum cross-sectional dimension of the passageways provided by the tube 19. Sufficient pressure will be created in the containers forming the source of supply 18 for maintaining the material 16 in the head under just the proper pressure to cause the droplets to ooze therefrom as they are dispersed by the applied electrostatic force.

As illustrated, the applicator head is connected to a source of high voltage indicated at 20 through one terminal thereof, the other terminal of said source being grounded at 21 and through ground connected with an article 10 to be coated. Accordingly, the space or field between the applicator head and article 10 is electrostati-

cally charged by reason of the article being grounded and the applicator head being at high potential. The effect thereof is to cause an electrical force to act on the droplets 17, causing them to be broken up into finely divided or minute particles of coating material, such as to be attracted to the grounded article for deposition thereon. Thus, the grounded article may be referred to as a collecting electrode of one potential with the applicator head serving as a discharge electrode of a different potential. It is found that the electrostatic force set up in the field between the electrodes is such as to develop and transmit finely divided particles of the droplets 17 from one electrode to the other. In this connection it will be noted that as the droplets are caused to slowly ooze from the applicator head they are inactive or inert, but subject to being broken up into finely divided particles and distributed over the surface of the opposed electrode. The same action will take place wherein the applicator head may be grounded and the article directly connected with the source of high voltage and thus be charged at a high potential.

Another modification is illustrated in Figs. 3 and 4, wherein the applicator head 113 is adjustably supported by the handle 114 through a pivotal connection secured by thumb nut 115. The hose 119 leading from a source of coating material maintained under pressure, is connected with a valve operated conduit 120 controlled by the finger operated valve 121. Also, the droplets of coating material 117 may be controlled, depending upon the viscosity of the material indicated at 116 by a needle adjustment 122, which needle adjustably controls the orifice through which the material 116 is forced to provide the desired inert droplets.

Figs. 5 and 6 show a further modification of the applicator head indicated at 213. In this head the orifices through which the coating material flows are provided by a plate 214 clamped between opposed rows or needles 215. The needles are cylindrical so that the material will be caused to flow between them, the plate 214 and the clamping walls 216 so as to come out in the form of an inert droplet 217 of coating material. As illustrated in the drawings, the needles are sufficiently close together as to cause the coating material to bridge the spaces therebetween.

In the modification of Figs. 7 and 8 there is illustrated a grounded surface 310 to be coated. This may be a continuously moving sheet of paper or any other article, it being understood that wherein such article or material is non-conducting, it is carried by and on a support or conveyor 311 of grounded conducting material. In this arrangement the applicator head 313 is supported across and above the surface to be coated, and coating material is fed thereto through the valve controlled pipe 319 leading from the source of such material. Said pipe extends through the head, having a series of orifices or openings therein through which the material may drip by gravity. Mounted on and connected to a source of high voltage through the pipe 319, there is a supporting shield 314 extending downwardly and terminating below the pipe to provide a frame for a wire wrapping 315. The coating material accumulates from the drippings into a pocket formed by the wire wrappings, as indicated at 316. The wire wrappings are slightly or sufficiently spaced to permit the coating material to slowly ooze or drip therebetween from the accumulation in the pocket indicated at 316 to form the droplets 317. In this instance the discharge or oozing of the material from the applicator head is aided by gravity, the droplets being thereupon broken up or developed into finely divided particles by the electrostatic force developed between the applicator head and the surface to be coated. Such finely divided particles will thereupon be dispersed by the electrostatic force over said surface and be applied to said surface. The applicator head can be grounded and the work maintained at high potential with equally efficient results.

By way of example, the arrangement of the overhead applicator of Fig. 7 is shown diagrammatically in Fig. 9, wherein the source of high voltage indicated at 320 has one terminal grounded at 321 and the other terminal connected with the applicator head 313 which is thereby maintained at high potential relative to the support or conveyor 311, which is connected with ground at 312.

As above pointed out, it is immaterial as to whether the article or the applicator head comprises the grounded electrode, since the electrostatic force set up therebetween will have the same effect on the droplets of coating material. Also, it is immaterial as to whether or not the article to be coated is of conducting or non-conducting material, and such article of non-conducting material is herein considered to be one of the electrodes wherein it is associated with or masks a grounded support of conducting material.

The invention claimed is:

1. In apparatus for electrostatically applying liquid coating material to an article, an atomizing head positioned adjacent the article to be coated, said head comprising a group of elongated members and means for encasing said members and intimately compacting them together, said members projecting for a portion of their length beyond said encasing means, means for maintaining between said projecting member portions and the article an electrostatic field of sufficient strength both to electrostatically atomize fine particles from coating material on the surfaces of said projecting portions and to electrostatically deposit on the article the particles so atomized, and means for supplying liquid coating material to said members from their encased ends to the surfaces of said projecting portions at a rate no greater than that at which it is electrostatically atomized.

2. In an apparatus for electrostatically coating an article with a liquid coating material, an elongated, hollow applicator head comprising supporting means having thereon a wire wrapping having a series of spaced turns, portions of which constitute projections and the spaces between which constitute restricted orifices through which liquid coating material can flow to the surfaces of said projections, means for supplying liquid coating material to the interior of said head, and means for creating between said head and an article to be coated an electrostatic field of sufficient strength both to electrostatically atomize finely divided particles from coating material on the surfaces of said projections and to electrostatically deposit upon the article the particles so atomized.

3. Apparatus for electrostatically coating an article with a liquid coating material, comprising a conveyor for moving the article over a predetermined path, a single-fluid atomizing head provided with a liquid supporting, flow-guiding surface having a terminus adjacent which liquid coating material is to be atomized, means for supplying liquid coating material at a controlled rate to said surface at a point spaced rearwardly from said terminus for flow as an exposed body over the surface to said terminus for atomization therefrom, and means including a high-voltage source having its opposite terminals electrically connected to the article on the conveyor and the liquid at said terminus for establishing an electrostatic field therebetween capable of atomizing the liquid from said exposed body at said terminus in the form of a spray and electrostatically depositing the spray on the article while still in liquid state, said head and conveyor being spaced apart by a distance great enough to permit the atomized liquid leaving said member to be widely dispersed.

4. Apparatus for electrostatically spray-coating an article, comprising an atomizing head, means for feeding liquid coating material to said head, means including said feeding means for distributing coating material to an extended atomizing zone where it is atomized from a plurality of spaced points, said points being sufficiently close together to permit the coating material to bridge the spaces therebetween, a support for supporting an arti-

to be coated in spaced relation to said atomizing zone, and means including a high-voltage source for creating over the surface of the article on said support an electrostatic field capable of atomizing the coating material into finely divided, electrically charged particles and electrostatically depositing particles atomized from said atomizing zone on the article while still in liquid state, said atomizing head and support being so relatively disposed as to provide between the article and the atomizing zone a spacing great enough to permit substantial dispersion of the atomized particles by the electrostatic forces of the field.

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Jan. 11, 1944. J. S. SMYSER Re. 22,419

METHOD FOR MAKING ABRASIVE ARTICLES AND APPARATUS THEREFOR

Original Filed Feb. 7, 1924 2 Sheets-Sheet 1

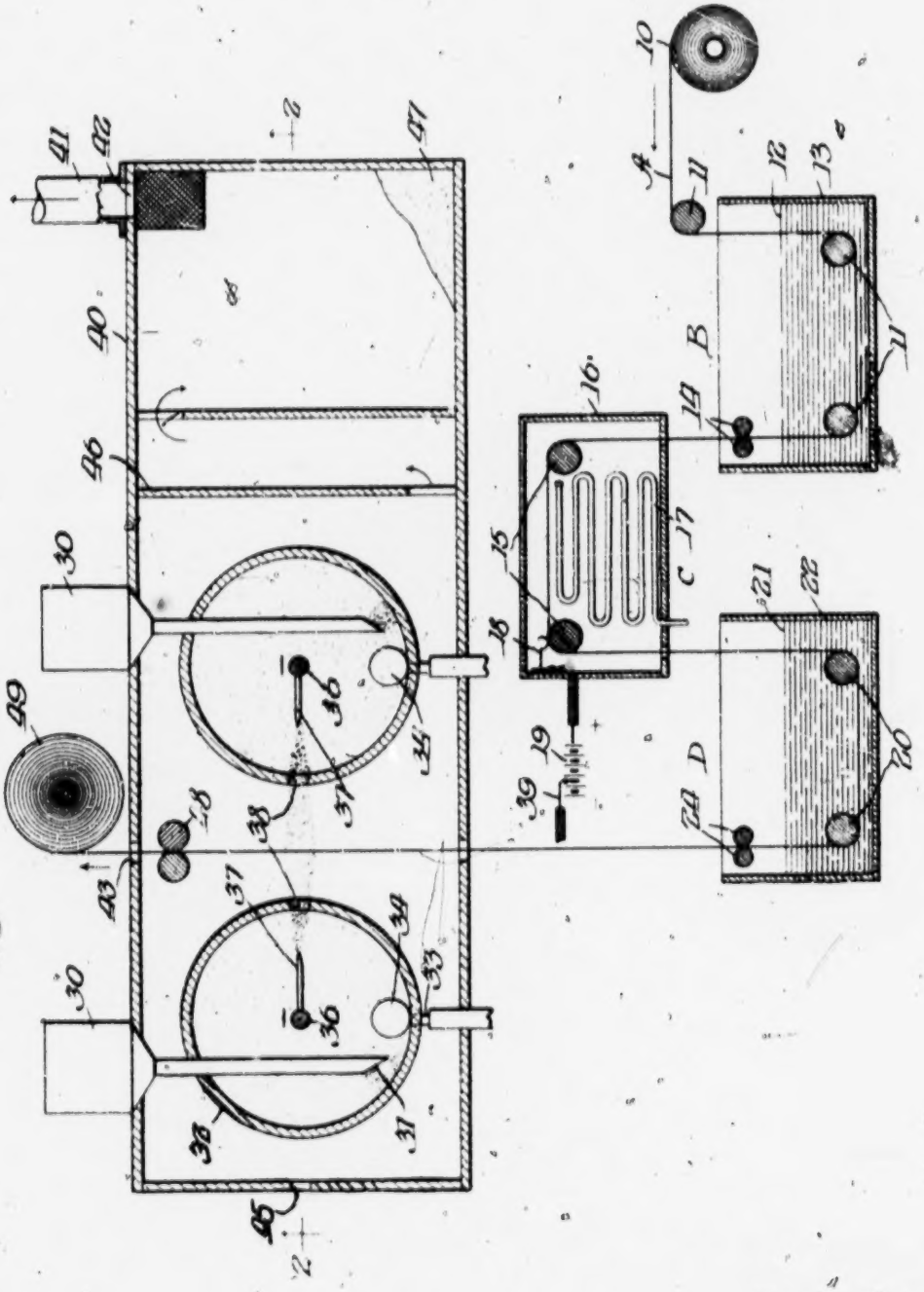

Fig. 1.

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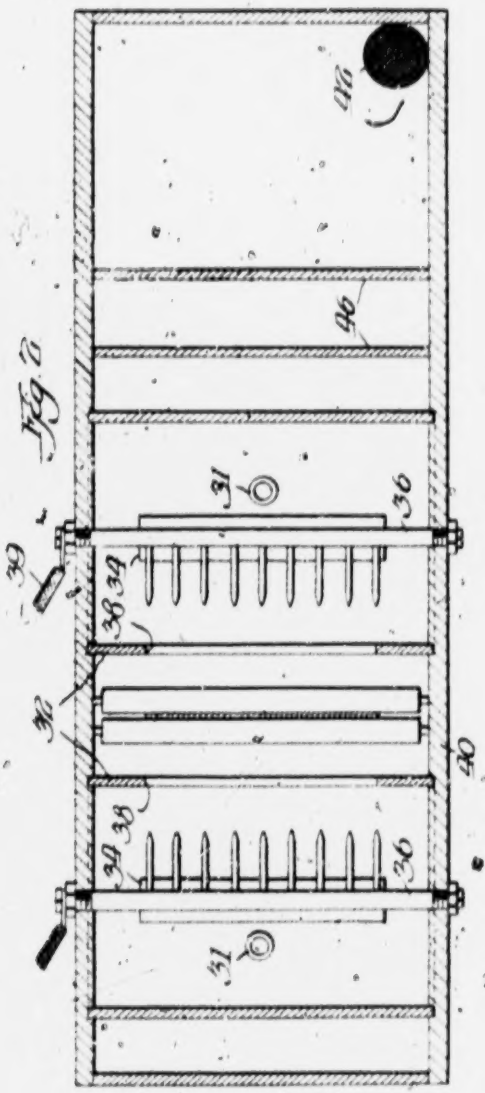
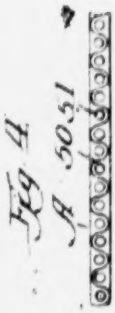
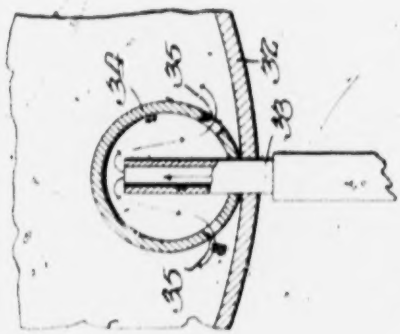
METHOD FOR MAKING ABRASIVE ARTICLES AND APPARATUS THEREFOR

Original Filed Feb. 7, 1924 2 Sheets-Sheet 2







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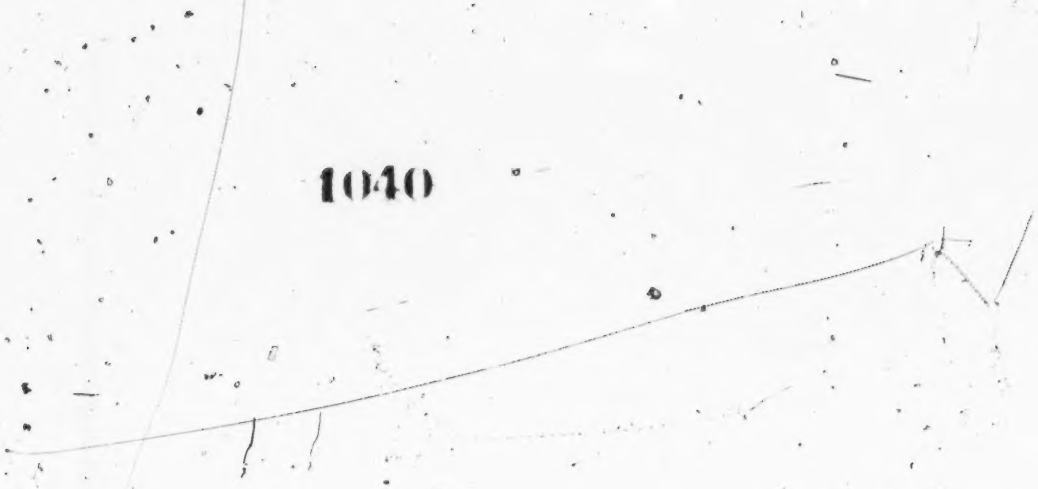

UNITED STATES PATENT OFFICE

22,419

METHOD FOR MAKING ABRASIVE ARTICLES AND APPARATUS THEREFOR

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Original No. 1,788,600, dated January 13, 1931, Serial No. 691,149, February 7, 1924. Renewed April 14, 1936. Application for reissue April 24, 1931, Serial No. 532,674.

59 Claims. (Cl. 117—17)

This invention relates to articles of manufacture consisting of a support, and a layer of comminuted material deposited thereon; and more particularly to producing and maintaining the physical union of the material and the support. The invention is especially useful in coating strips or sheets of fabric, paper or the like with abrasive particles as hereinafter described in connection with illustrative embodiment.

Objects of my invention are to provide a simple, and efficient method of producing an abrasive surface on a fabric or other article serving as a base, without materially affecting the flexibility or strength of the article; to provide an electrostatic method of continuously, and progressively producing an abrasive coating on a sheet of fabric, or other article, as it is moved in substantially the direction of its surface; to provide an improved coated fabric or other article; and generally to provide an improved method of and apparatus for producing an abrasive coating on an article.

In one aspect my invention contemplates electrostatically applying an abrasive coating to a fabric, or other article serving as a base, by electrostatically projecting abrasive particles into engagement or binding contact with the article being coated, and then forcing the engaged particles into more intimate engagement with the article.

In another aspect, an abrasive coating is electrostatically applied to an electrically non-conducting article by providing a conducting path extending over the article, applying a coating of binding material to the article, and bombarding the last applied coating by a stream of abrasive particles electrostatically charged oppositely to the conducting path of the article.

In still another aspect, the invention provides a fabric or other article coated with a conducting material having a superposed coating of binder material upon which there is deposited a coating of granular material.

The article, when in sheet form, may be coated by moving the sheet continuously in substantially the direction of its surface; dipping a portion of the sheet into a liquid bath having comminuted conducting material in suspension, to coat the sheet; drying the liquid from the coating to leave a conducting path over the surface of the sheet; making a sliding contact between the conducting portion of the sheet and one terminal of a source of electromotive force; dipping the sheet in a liquid bath of binding material to leave a coating of the binder on the sheet; equalizing the distribution of the binder coating on the sheet; moving the sheet through a stream of abrasive particles which are electrostatically charged by the source of electromotive force with a sign opposite to that of the conducting path of the sheet; equalizing the distribution of abrasive particles over the surface of the sheet, and forcing the particles into more intimate engagement with the sheet.

Methods and apparatus illustrating a species, of which my invention is a genus, are described more fully hereinafter in connection with the accompanying drawings, in which:

Fig. 1 is an elevation, in section diagrammatically showing apparatus for preparing an abrasive coating on a sheet of fabric;

Fig. 2 is a plan of a portion of Fig. 1;

Fig. 3 is an enlarged view of a portion of Fig. 1;

Figs. 4, 5, 6 and 7 are cross sections of a fabric in successive stages, respectively, of the coating operations.

In Fig. 1 the sheet A of fabric, paper, or similar material, is moved substantially in the direction of its surface and directed by rollers so that it passes continuously through a series of zones B, C, D and E, in each one of which the sheet is subjected to a different operation.

The sheet A feeds from the roll 10 in the direction indicated by the arrow into the coating zone B where it passes around rollers 11, and dips into the liquid bath 12 in tank 13, the liquid having in suspension granular or comminuted graphite or other conducting material. The liquid is preferably non-corrosive and without appreciable physical or chemical effect upon the sheet when used primarily to suspend the conducting particles; it may be water or other suitable liquid. The sheet passes between the rollers 14 which remove the excess of the mixture from the sheet, resulting in a substantially uniform distribution of conducting material throughout. The rollers 15 direct the sheet through a drying zone C within the chamber 16, having a heating element 17, such as a steam pipe, or other heater. The liquid upon drying from the coating on the sheet leaves the conducting material distributed over the surface as a conducting path. The brush 18 in contact with the sheet is connected to the positive terminal of the source of electromotive force 19 which electrifies the conducting path of the sheet with a charge of positive sign.

Rollers 20 direct the sheet through the zone D, in which, a coating of binding material is applied to the sheet as it dips into the liquid bath 21 of binding material, such as paraffin, or other suit-

able binder, preferably electrically non-conducting, in tank 22, heated by a steam pipe (not shown), or other suitable means. The rollers 24 remove the excess liquid and distribute the coating uniformly over the surface to equalize its thickness.

In the zone E, a coating of abrasive is electrostatically applied to the sheet. The hoppers 30 for containing abrasive particles of emery, carborundum, pumice, or other suitable abrasive material having the size of particle with which it is desired to coat the sheet, discharge through spouts 31 into the cylindrical electrifying chambers 32, preferably of electrically insulating material, disposed on opposite sides of the upwardly moving sheet. The nozzles 33 discharge air into the conduits 34 (see Fig. 3), these conduits having apertures 35 which admit the moving air at suitable pressure to the abrasive container 40 to produce a condition in which the abrasive particles are temporarily suspended in the atmosphere of the container into which the particles enter through orifices 38 into the zone of the electrical discharge, which takes place between the needles 37 mounted on bus-bars 36 and the conducting sheet.

Bus bars 36 are connected preferably to the negative terminal of source of electromotive force 19 by means of leads 39, the effective potential of the source 19 being adjusted to such a value, e. g. 18,000 volts, more or less, than the abrasive particles in chamber 32 become electrified with a negative charge, and together with the air admitted through nozzle 33 discharge through slot 38 as a stream of electrified particles which are electrostatically propelled toward the positively charged sheet A, the solid particles bombarding and coming into engagement with the binder coating on the sheet. It will be seen that the electrostatically propelled abrasive particles emerging from each of the orifices 38 become deposited as a thin blanket on the sheet A as it passes through the discharge zone.

The housing 40 for apparatus in the zone E prevents loss of the abrasive particles which fail to become attached to the sheet A, and is preferably constructed of insulating material. Conduit 41 is connected to an exhaust pump (not shown) and exhausts air from the housing 40 in the direction indicated by the arrow, the end of conduit 41 being covered by a screen 42 which sifts the abrasive particles from the air before entering the conduit. Air free from abrasive particles is admitted through openings 43, 44 and 45, thus tending to clarify the air within the housing and together with the air discharged through slots 38 causing a flow of the air and drift of the abrasive particles around the baffle diaphragms 46 as indicated by the arrows, the baffles tending to cause a precipitation of the particles at one end of the housing as indicated by the accumulation 47 which also includes the abrasive sifted by the screen 42. Owing to the reduced air pressure in housing 40 when air is exhausted through conduit 41, air may be fed through nozzles 33 directly from the atmosphere, but if a greater flow is desired compressed air may be fed through these nozzles.

Rollers 48 between which the sheet passes, after being coated with the abrasive, equalizes the distribution of abrasive material on the surface of the sheet and forces the abrasive particles into more intimate engagement with the sheet which then passes upward and is wound on the roll 49. The sheet may be propelled by rotation of the roll 49 or one or more of the rollers with which the sheet contacts between rolls 10 and 49.

Figure 4 shows the appearance of a simple fabric sheet A, of electrically insulating or poorly conducting material, having a warp 50 and a woof 51, before the sheet has entered the coating zone B. Fig. 5 shows the particles 52 of graphite or other conductor distributed over the surface of the fabric after the liquid from the batch 12 has been evaporated from the surface in the drying zone C and before the sheet has entered the coating zone D. Fig. 6 shows the sheet A with the coating 53 of paraffin, or other binding material before the sheet enters the coating zone E. Fig. 7 shows the completed abrasive sheet having a coating 54 of abrasive particles distributed over the binder coating on each side of the sheet A.

By virtue of the electrostatic charges upon the abrasive particles as they pass to the fabric they are held apart by electrostatic repulsion and consequently are distributed far more effectively than is possible without the use of an electrostatic field. Thus the abrasive material may be deposited in any degree of depth, from an extremely thin deposit approximately one particle thick to a thick deposit, and in any case the particles are distributed with great uniformity. By coating the fabric upon both sides its usefulness is practically doubled and by virtue of the roughness of the rear side the article can be used more effectively with less danger of slippage in the fingers.

While certain materials have been mentioned in disclosing an example of how the invention may be carried out, it is to be understood that the materials specifically named are not necessary to the invention but may be replaced by other suitable materials. It is obvious that the sheet may be treated in the various zones B, C, D and E by various modifications of the apparatus disclosed within the knowledge of those skilled in the art.

The method, and apparatus disclosed for carrying out the method, permit of producing an abrasive coating on sheet fabric or other articles, particularly those in which it is desired to provide a certain degree of elasticity or flexibility, without objectionably stiffening the sheet or otherwise materially affecting those properties of the sheet which it is desired to preserve.

Owing to the more commonly elongated nature of abrasive particles, they tend to align themselves in the electrical field and are thus projected or bombarded against the adhesive coating with their longer dimension perpendicular thereto, thus permitting a nesting of the particles with respect to each other in the adhesive coating. Furthermore this permits of the adhesive coating exercising its capillary attraction, so that it will more readily rise along the sides of each individual abrasive particle and catch and hold additional particles subsequently applied before setting of the adhesive.

One of the inherent characteristics of the article produced by the improved method and apparatus disclosed herein resides in the fact that a major portion of the abrasive particles embed themselves in the adhesive coating and assume positions with their greater dimensions perpendicular or substantially perpendicular to the plane of the carrier, that is a sheet of fabric or paper as the case may be. Thus I am enabled to provide an abrasive article wherein the abrasive particles of grit may be applied in greater number to a predetermined area with a given quantity of adhesive than in the case of any other method or

article known to me. I have, therefore, provided a new article of manufacture wherein the cutting edges or points of the abrasive particles are presented toward the surface to be abraded and materially enhance the efficiency of the abrasive article such as increasing its cutting ability and as well as its ability to keep clean.

I have found my improved method and apparatus peculiarly useful for the production of abrasive articles in view of the further following considerations. Abrasive particles present relatively sharper points or edges and, likewise, relatively less sharp portions. Where the particles are given an electrostatic charge, the density of the charge is greater at the points or edges than on any relatively more or less flat part of the surface of the particle. For this reason, the particle projected electrostatically aligns itself so that the sharpest point or edge points in the direction of the electrostatic field as it arrives at the adhesive coated surface. Inasmuch as I direct the electrostatic field I employ so that it acts perpendicularly to the surface coated with the adhesive, the particle acted upon so attaches itself to the adhesive surface as to present its sharpest cutting edge or point outwardly of the surface and in the direction of the electric field.

I am thereby enabled to produce an abrasive coating of extraordinary sharpness even with particles which are not necessarily markedly elongated, as well as when I employ the more common abrasive particles of an elongated contour. Thus I am enabled to attain an alignment of particles by means of an electrical field which affords a surface coated abrasive presenting the greatest number and most effective cutting points and edges known to me and one characterized by extraordinary cutting ability.

In the claims where I have referred to the abrasive particles being dispersed with major effectiveness for abrasively coating said backing, I mean to include the result produced in depositing grit or abrasive particles under the influence of an electrical field such as an electrostatic field to which effect I attribute a tendency to an orientation, positioning or displacement of the abrasive particles with the longer axes more or less perpendicular to the backing.

Reference is made to my divisional application Serial No. 640,978, filed Nov. 3, 1932, for Abrasive articles, wherein the article is claimed.

I claim:

1. Apparatus for applying coatings to electrically non-conducting sheet material, comprising means for feeding the sheet in substantially the direction of its surface, means for coating the moving sheet with a conducting material, means for applying a coating of binder material over said conducting coating, and means for electrostatically bombarding the binder coating with electrically charged particles to produce a coating upon said binder coating.

2. Apparatus for applying coatings to electrically non-conducting sheet material, comprising means for propelling the sheet substantially in the direction of its surface, means for applying to the sheet a coating of liquid having conducting particles in suspension, means for drying the liquid to leave conducting particles as a coating on the sheet, means for applying a coating of binder material to the sheet, and means for electrically projecting a stream of granular matter into engagement with the binder coating to apply a superficial coating to the sheet.

3. The method of electrostatically depositing a coating upon an article comprising agitating granular matter in the presence of an electric field, confining movements of the agitated particles to a restricted zone, and electrostatically projecting the electrified particles outwardly from the restricted zone to the object to be coated.

4. The method of preparing an abrasive coating on fabric or similar material, which comprises continuously moving the sheet in substantially the direction of its surface, progressively dipping the sheet in a liquid bath having finely divided conducting material in suspension, drying up the liquid left as a coating on the sheet and leaving the suspended particles deposited on the sheet to form a conducting path over the surface of the sheet, coating the sheet with a binder, equalizing the thickness of the binder coating, electrostatically projecting a stream of abrasive particles against the sheet, and forcing the abrasive particles into closer engagement with the sheet.

5. The method of preparing an abrasive coating on a sheet of fabric or similar material, which comprises moving the sheet substantially in the direction of its surface, dipping the sheet in a liquid bath having comminuted conducting material in suspension, drying up the liquid left as a coating on the sheet and leaving the suspended material deposited to form a conducting path over the surface of the sheet, dipping the sheet in a bath of liquid binding material, and electrostatically depositing a coating of abrasive particles on the binder.

6. The method of preparing an abrasive coating on a sheet of fabric or similar material, which comprises passing the sheet through a liquic having comminuted conducting material in suspension, withdrawing the sheet from the liquid and drying the liquid to leave a coating of conducting material on the sheet, coating the sheet with a binding material, and electrostatically projecting abrasive particles into engagement with the coating of binding material.

7. The method of preparing an abrasive coating on a sheet of fabric or similar material, which comprises coating the sheet with an electrically conducting material electrostatically projecting abrasive particles into engagement with the sheet and forcing the engaged abrasive particles into more intimate engagement with the sheet.

8. The method of preparing an abrasive coating on a sheet of fabric or similar material, which comprises continuously moving the sheet in substantially the direction of its surface, progressively coating the sheet with a liquid having comminuted conducting material in suspension, progressively drying the liquid to leave the suspended material as a conductive coating on the sheet, progressively coating the sheet with a binding material, and progressively bombarding the sheet with a stream of abrasive particles electrically charged oppositely to the conducting coating of the sheet.

9. The method of preparing an abrasive coating on a sheet of fabric or similar material which comprises continuously moving the sheet in substantially the direction of its surface, progressively depositing a conducting coating on the sheet, projecting a stream of abrasive particles electrified oppositely to the conducting coating into engagement with the sheet, and securing the engaged abrasive particles into more intimate engagement with the sheet.

10. The method of preparing an abrasive coating on an electrically non-conducting base, which comprises coating the base with an electrically

conducting material, coating the conducting material with a binding material, and electrostatically projecting a stream of abrasive particles into engagement with the binder coating.

11. The method of making an abrasive article which comprises rendering a sheet of fabric or the like both conductive and adhesive and by oppositely charging the conductive sheet and comminuted abrasive material adjacent thereto, electrostatically depositing a layer of said material upon the adhesive surface thereof.

12. The method of coating a sheet of material with abrasive particles which comprises rendering the sheet both conductive and adhesive and, by oppositely charging the conductive sheet and abrasive particles in the region of the sheet, electrostatically depositing the abrasive particles upon the adhesive surface of the sheet.

13. The method of coating a sheet of material with abrasive particles which comprises rendering the sheet both conductive and adhesive, continuously agitating a supply of abrasive particles in an enclosed region, continuously feeding the sheet along a path associated with said region, and by oppositely charging the conductive sheet and abrasive particles in said region electrostatically embedding the particles upon the adhesive surface of the sheet.

14. Apparatus for applying adhesive material to an electrically conducting surface and depositing thereon finely divided particles under the influence of an electrostatic field, comprising means for moving the surface in substantially the direction of its length, means for applying adhesive material to the surface, and means for electrostatically bombarding the adhesive material with electrically charged particles to produce a coating upon said adhesive material.

15. Apparatus for applying finely divided particles to a surface previously rendered electrically conducting and adhesive, comprising means for producing an electrostatic field in a region containing finely divided particles and means for moving the surface through said electrostatic field.

16. The method of electrostatically depositing finely divided material particles upon an article, which comprises establishing an electrostatic field, dispersing the finely divided material particles to form a suspension in a region containing the electrostatic field, confining movements of said particles to a restricted zone and electrostatically projecting them to the article to be coated.

17. The method of spreading an abrasive coating on a sheet of fabric or similar material which comprises treating the sheet to render it electrically conductive and mechanically adhesive, establishing an electrostatic field of force between the surface to be coated and a charged conductor of opposite polarity to that of the sheet and adjacent thereto, conveying finely divided abrasive particles into the electrostatic field of force and moving the surface progressively and in substantially its own plane through the electrostatic field of force whereby the abrasive particles may, by the action of the electrostatic field of force upon them, be deposited thereon.

18. The method of spreading a coating of finely divided particles on a sheet of fabric or similar material which comprises treating the sheet to render it electrically conductive and mechanically adhesive, establishing an electrostatic field of force between the surface to be coated and a charged conductor of opposite polarity to that of the sheet and adjacent thereto, conveying the finely divided particles into the electrostatic field of force, and moving the surface progressively and in substantially its own plane through the electrostatic field of force whereby the finely divided particles may, by the action of the electrostatic field of force upon them, be deposited thereon.

19. Apparatus for depositing finely divided particles on the surface of a fabric or other material comprising means for treating the fabric to render it electrically conductive and mechanically adhesive, means for establishing an electrostatic field of force between two electrodes of opposite polarity one of which is in electrical contact with the surface of the fabric, means for conveying the finely divided particles into the electrostatic field of force where, under its influence, they will be deposited on the surface of the fabric, and means for progressively moving said surface in substantially the direction of its length.

20. Apparatus for depositing finely divided abrasive particles on the surface of a fabric or other material comprising means for treating the fabric to render it electrically conductive and mechanically adhesive, means for establishing an electrostatic field of force between two electrodes of opposite polarity one of which is in electrical contact with the surface of the fabric, means for conveying the finely divided abrasive particles into the electrostatic field of force where, under its influence, they will be deposited on the surface of the fabric, and means for progressively moving said surface in substantially the direction of its length.

21. The method of coating, with pulverized material, a surface that is both electrically conductive and mechanically adhesive comprising establishing an electrostatic field of force between two electrodes of opposite polarity one of which is in electrical contact with the surface to be coated, conveying the pulverized material into the electrostatic field of force under the action of which it will be translated to the surface to be coated, and subjecting successive parts of the surface to the combined action of the electrostatic field of force and the pulverized material in a manner that will be substantially continuous.

22. The method of coating, with finely divided abrasive material, a surface that is both electrically conductive and mechanically adhesive comprising establishing an electrostatic field of force between two electrodes of opposite polarity one of which is in electrical contact with the surface to be coated, conveying the finely divided abrasive material into the electrostatic field of force under the action of which it will be translated to the surface to be coated, and subjecting successive parts of the surface to the combined action of the electrostatic field of force and the finely divided abrasive material in a manner that will be substantially continuous.

23. The method of spreading a coating of finely divided material upon an electrically conductive surface, which comprises establishing an electrostatic field of force between two electrodes of opposite polarity, one of which is in electrical contact with the surface to be coated, conveying the finely divided material into the electrostatic field of force under the action of which it will be translated to the surface to be coated, and bonding the finely divided material to the surface to be coated.

24. In the manufacture of abrasives, the improved method which consists in providing a carrier having a surface coated with an adhesive, depositing finely divided abrasive material upon said surface and dispersing the particles by the action of an electrical field as they are being deposited upon the surface.

25. In the manufacture of abrasives, the improved method which consists in depositing abrasive particles upon a carrier surface, providing an adhesive material for retaining the particles on the carrier, and dispersing the particles by the action of an electrical field as they are applied to the carrier.

26. In the manufacture of abrasives, the improved method which consists in providing a carrier having a surface coated with an adhesive, depositing finely divided nonmagnetic abrasive material upon said surface and dispersing the particles upon the surface by the action of an electrical field.

27. In the manufacture of abrasives, the improved method which consists in providing a carrier having a surface coated with an adhesive, directing abrasive particles toward said adhesively coated surface, and controlling the position of the particles relative to one another on the carrier by an electrical field.

28. In the manufacture of abrasives, the improved method which consists in providing a carrier having a surface coated with an adhesive, directing abrasive particles toward said adhesively coated surface, and controlling the position of the particles relative to one another in their path to the carrier and on the carrier by an electrical field.

29. Apparatus for the manufacture of abrasives, comprising means for supporting a carrier having a surface coated with an adhesive adapted to receive and retain abrasive particles, means for supplying abrasive particles and directing the same toward said surface, and an electrical field disposed in the path of said particles so as to control the arrangement of the same relative to one another at the time they are deposited upon the carrier.

30. In the manufacture of abrasives the improved method of depositing abrasive particles upon a carrier surface which includes providing an adhesive material for retaining the particles on the carrier and projecting the particles substantially longitudinally of their axes by the action of an electric field as they are applied to the carrier.

31. In the manufacture of abrasives the improved method of depositing particles upon a carrier surface which includes providing an adhesive material for retaining the particles on the carrier, forming a suspension of said abrasive particles in a defined zone, and projecting particles from said zone onto the carrier by the action of an electrical field.

32. In the manufacture of abrasives the improved method of depositing particles upon a carrier which includes providing an adhesive material for retaining the particles on the carrier and projecting the particles onto the carrier by the action of an electrical field independently of mechanical pressure.

33. In the manufacture of abrasives, the improved method of depositing particles upon an adhesive carrier which includes moving the particles into adhesive engagement with the carrier in spaced relationship to each other the deposition being effected under the influence caused by the action of electrical force creating an electrical field affecting the spaced relationship of the particles aforesaid.

34. In the manufacture of abrasives, the improved method of depositing particles upon an adhesive carrier which includes moving the particles into adhesive engagement with the carrier in substantially a single layer the deposition being effected under the influence caused by the action of electric force creating an electrical field affecting the particles in the movement aforesaid.

35. In the manufacture of abrasives, the improved method of depositing particles on an adhesive carrier which consists in moving the particles into adhesive relation with the carrier, the deposition being effected under the influence caused by the action of electric force creating an electrical field affecting the particles in the movement aforesaid.

36. In the manufacture of abrasives, the improved method of depositing particles of elongated character thereby having different degrees of effective cutting portions upon a carrier which includes providing an adhesive material for retaining the particles on the carrier and projecting the particles onto the carrier, the deposition being effected under the influence caused by the action of an electrical field acting perpendicular to the surface of the carrier whereby they are deposited on the carrier with their major effective cutting portions in the direction of the electrical field.

37. In the manufacture of abrasives, the improved method of depositing the abrasive particles upon a carrier surface which includes providing an adhesive material for retaining the particles on the carrier and projecting the particles onto the carrier by the action of an electrical field established by a high potential.

38. In the manufacture of abrasives, the improved method of depositing particles upon a carrier which includes providing an adhesive material for retaining the particles on the carrier and projecting the particles onto the carrier by the action of an electrical field and controlling the quantity of the particles deposited on the carrier by variation in the quantity of the particles brought within the electrical field.

39. In the art of making flexible abrasives, the provision of a continuously flexible carrier web, applying a hardenable adhesive material to said carrier web, progressively feeding said carrier web while the adhesive is soft and receptive into the presence of a supply of pulverulent abrading material, activating the abrading material adjacent to the carrier to form an extended arrangement of particles, and impressing an electrical field on such activated abrasive material for moving it onto the carrier with the major portion of the individual particles thereof having their longitudinal axes substantially perpendicular to the carrier web.

40. In the art of making flexible abrasives, the provision of a continuously flexible carrier web, applying a hardenable adhesive material to said carrier web, progressively feeding said carrier web while the adhesive is soft and receptive into the presence of a supply of pulverulent abrading material, activating the abrading material adjacent to the carrier to form an extended arrangement of particles, directing the thus activated particles into a predetermined zone adjacent to said carrier web, and impressing an electrical field on the thus activated abrasive

particles for moving them into intimate adhesive engagement with the carrier web.

41. In the manufacture of abrasives, the improved method which consists in providing a carrier having a surface coated with an adhesive, depositing finely divided abrasive material upon said surface by an electrical field, the particles being thereby held apart and consequently more effectively distributed as they are deposited upon said surface carrying said adhesive.

42. In the manufacture of abrasives, the improved method which consists in providing a carrier having a surface coated with an adhesive, coating the adhesive surface with the abrasive by passing the abrasive particles to the carrier and holding them apart by an electrical field whereby they are projected onto the carrier in spaced relationship relatively to each other.

43. An apparatus for the manufacture of coated carriers comprising means for supplying a controlled feed of finely divided solid material adapted to be dispersed by an electrical field, means for supporting an adhesively surfaced carrier to be coated, and means for producing an electrical field to disperse the individual particles of finely divided material upon said adhesive surface as the material is supplied thereto.

44. An apparatus for the manufacture of coated carriers comprising means for supplying a controlled feed of finely divided solid material adapted to be dispersed by an electrical field, means for supporting and causing to travel adjacent said supply means an adhesively surfaced carrier to be coated, and means for producing an electrical field to disperse the individual particles of finely divided material upon said adhesive surface as the material is supplied thereto.

45. In the manufacture of abrasives, the improved method which consists in providing a carrier having a surface coated with an adhesive, depositing finely divided abrasive material upon said surface and through the medium of an electrical field controlling the arrangement of the abrasive particles on the adhesive surface to cause the same to be substantially uniformly oriented with their major axes at substantially right angles to the adhesively coated carrier surface.

46. The process of making abrasive material which includes the step of depositing abrasive particles upon an adhesively coated backing, dispersing the individual particles and orienting them with major effectiveness for abrasively coating said backing by means of an electrical field.

47. The process of making abrasive material which includes the step of depositing abrasive particles upon an adhesively coated backing, dispersing and holding the individual particles apart whereby orientation thereof is accomplished with major effectiveness for abrasively coating said backing by means of an electrical field.

48. That step in the manufacture of abrasives to adhesively unite the abrasive to a carrier which comprises depositing finely divided abrasive material upon a carrier and through the medium of an electrical field controlling the arrangement of the abrasive particles on the carrier to cause the same to be substantially uniformly oriented with their major axes at substantially right angles to the carrier.

49. In the manufacture of abrasive including adhesively united abrasive particles forming an abrading surface, the step which comprises depositing finely divided abrasive particles and through the medium of an electrical field controlling the arrangement of the abrasive particles to cause the same to be substantially uniformly oriented with their major axes substantially at right angles to said surface.

50. In the manufacture of abrasives, the improved method which consists in providing a carrier, directing abrasive particles toward said carrier, controlling the position of the particles relative to one another in their path to the carrier by an electrostatic field and varying the relative positions of the particles in said path by adjusting the electrical field to such a value as to electrostatically propel the particles as desired.

51. A method of applying a finish to an article of manufacture, consisting in producing a uni-directional current of high voltage in an atmosphere, introducing a coating material in a finely divided form into the atmosphere, and subjecting the article of manufacture to be coated to the current and the atmosphere for a predetermined period of time to cause electrical deposition of the material upon the article of manufacture.

52. A method of applying a finish to an article of manufacture, consisting in enclosing a space of predetermined size, introducing into the enclosed atmosphere a coating material in a finely divided form, conveying the article of manufacture to be coated through the enclosed atmosphere, and subjecting the article of manufacture and the coating material to a difference of electrical potential to cause the coating material to be deposited on the article of manufacture.

53. The method of making sandpaper and other products coated with elongated particles which comprises separating elongated particles into a separated and temporarily suspended condition from a bulk source of supply by a force applied to said particles fed from said source, then introducing the particles so separated and suspended into a position between an impelling force comprising an electrical field and an adhesive coated backing, the particles thereby being presented into the position aforesaid to permit the particles to alter their position in respect of each other and then causing the particles to adhere substantially normally to the backing by the application of the electrical impelling force to said particles so introduced in the condition aforesaid.

54. The new article of manufacture comprising apparatus for forming a coating of abrasive and other pulverulent elongated particles upon an adhesively coated surface which includes, in combination, a hopper for said particles, and means acting upon the particles fed from said hopper causing the particles to be arranged in a separated and temporarily suspended condition, said means including additional means directing said particles towards said surface and which confines the movement of the particles within a zone ineffective alone to coat the surface towards which said particles have been directed by said means, and comprising an electrical field for impelling said particles from said zone against said adhesively coated surface to cause adhesion of said particles substantially normally to said surface.

55. The method of coating, with finely divided material, an article which is electrically conduc-

tive and has a mechanically adhesive surface comprising establishing an electrostatic field of force between two electrodes of opposite polarity, one of which is in electrical contact with the surface to be coated, introducing finely divided material into the electrostatic field of force under the action of which it will be translated to the surface to be coated and subjecting the surface to the combined action of the electrostatic field of force and the finely divided material for sufficient time to enable it to be substantially uniformly coated.

56. In the manufacture of an article having a coated surface, the improved method which consists in providing a carrier with an adhesive surface, introducing into the region of the adhesive surface, a finely divided coating material, depositing and arranging the finely divided coating material upon the adhesive surface by the action of an electrical field.

57. In the manufacture of articles having coated surfaces, the improved method of arranging finely divided material upon a surface which is mechanically adhesive, which comprises establishing an electrical field between electrodes of opposite polarity, disposing the surface to be coated within said field, introducing into the region of the adhesive surface a finely divided coating material, and projecting by means of the field against the surface the particles substantially longitudinally of their axes.

58. The method of applying a finish to an article of maufacture, consisting in producing an electrical field of high voltage in an atmosphere, introducing a coating material in a finely divided form into the atmosphere and subjecting the article of manufacture to be coated to the electrical field and the atmosphere for a predetermined period of time to cause electrical deposition and arrangement of the material upon the article of manufacture.

59. The method of applying a finish to an article of manufacture, consisting in enclosing a space of predetermined size, introducing into the enclosed atmosphere a coating material in a finely divided form, subjecting the article of manufacture to be coated to the enclosed atmosphere, and subjecting the article of manufacture and the coating material to a difference of electrical potential to cause the coating material to be deposited on the article of manufacture.

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1049

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APPARATUS FOR ELECTRICALLY CHARGING FLUIDS.

APPLICATION FILED OCT. 24, 1916.

1,360,654. Patented Nov. 30, 1920.

2 SHEETS—SHEET 1.

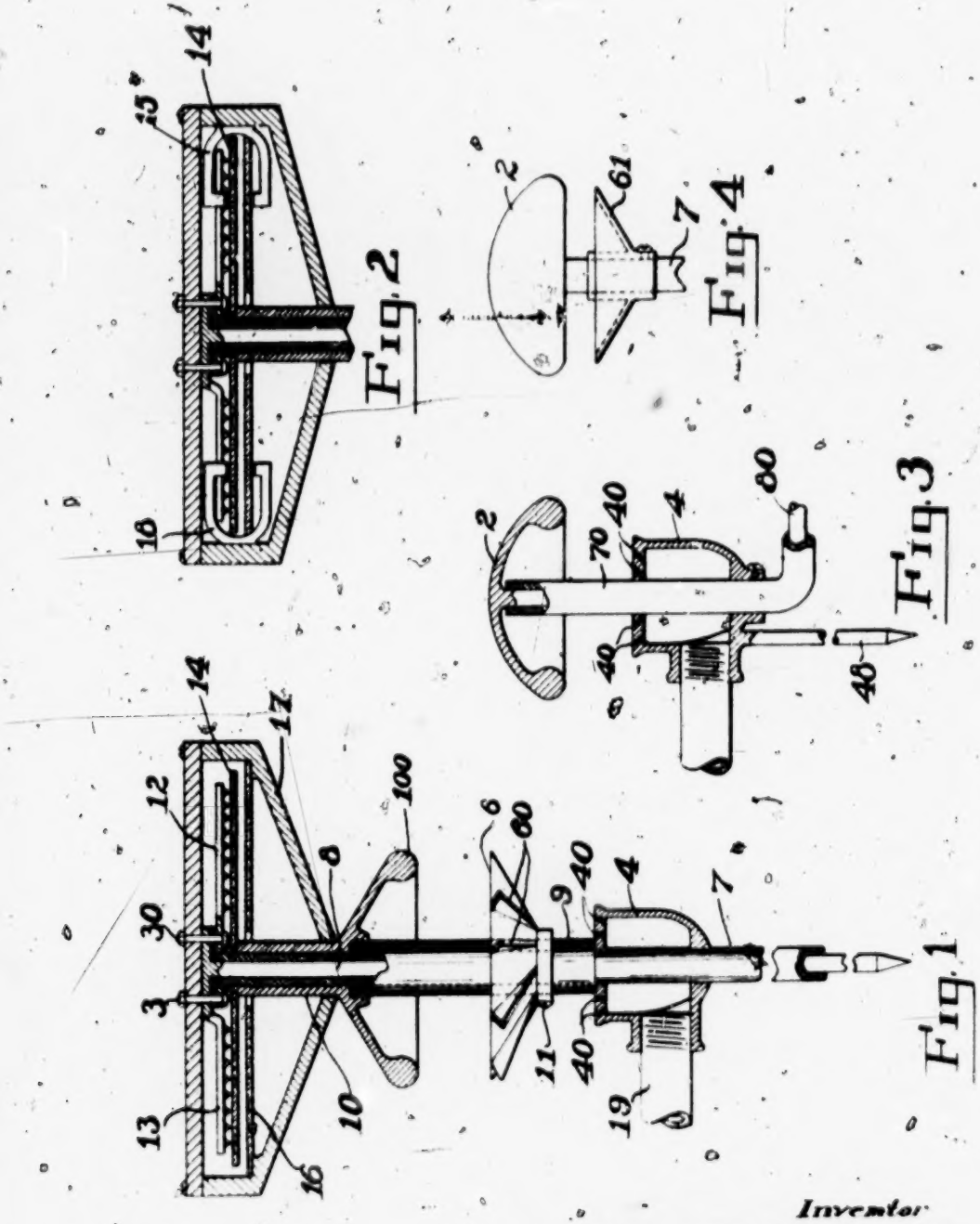

Fig. 2

Fig. 4

Fig. 3

Fig. 1

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APPLICATION FILED OCT. 24, 1916.

1,360,654. Patented Nov. 30, 1920.

2 SHEETS—SHEET 2.

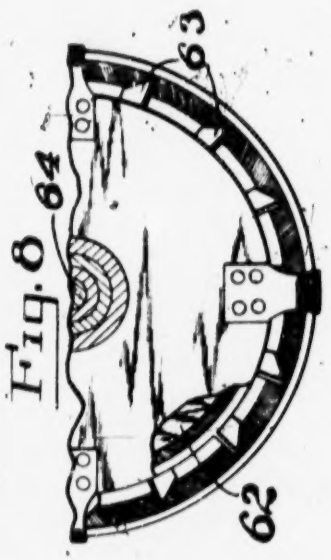

Fig. 8

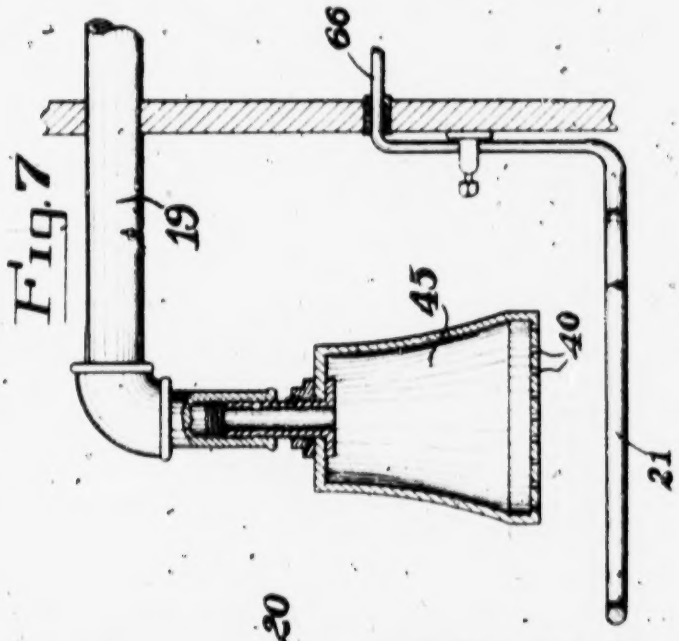

Fig. 7

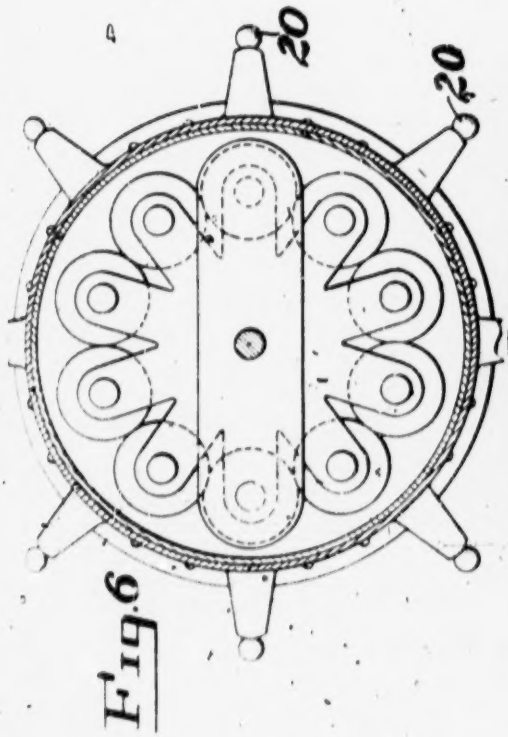

Fig. 6

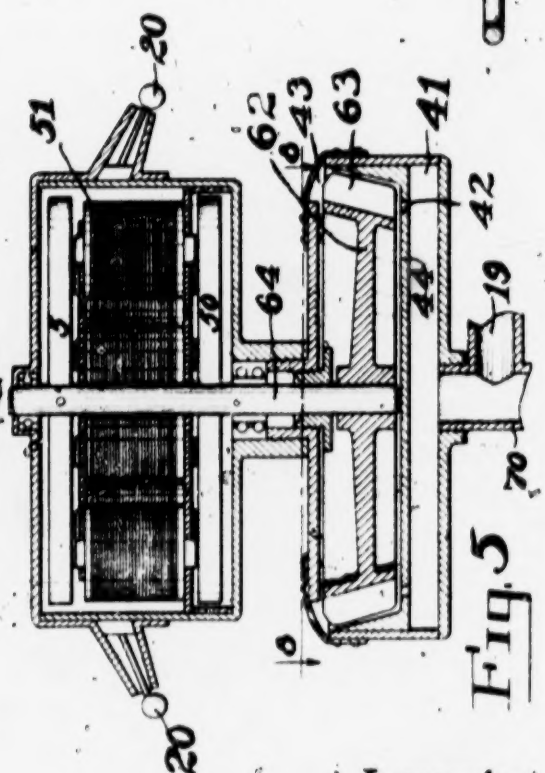

Fig. 5

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UNITED STATES PATENT OFFICE.

EDGAR EARLE LITTLEFIELD, OF SEATTLE, WASHINGTON

APPARATUS FOR ELECTRICALLY CHARGING FLUIDS

1,360,654. Specification of Letters Patent. Patented Nov. 30, 1920.

Continuation of application Serial No. 482,599, filed March 10, 1909. This application filed October 24, 1916. Serial No. 127,338.

To all whom it may concern:

Be it known that I, EDGAR EARLE LITTLEFIELD, a citizen of the United States, and resident of the city of Seattle, county of King, and State of Washington, have invented certain new and useful Improvements in Apparatus for Electrically Charging Fluids, of which the following is a specification.

My invention relates to apparatus for giving fluids an electrical charge, of such character that when the fluid is discharged, as by spraying, the electrical charge will be carried to and deposited upon the objects upon which the fluid falls.

The object of my invention is to provide an improved apparatus for securing these results. In particular, I have employed these means to electrically charge fluids which are, or may be, applied to vegetation to thereby produce upon the vegetation the stimulating effect which electricity is known to have thereon and further to free it of fungous or insect pests when applied under suitable conditions.

I have also applied these means to charge fluids which are, or may be, used in connection with shower baths, or the like, to thereby apply the stimulating effect of electricity to the user.

While it would be desirable in many cases to use the fluid in a comparatively pure state I contemplate that advantage may be taken of the increased effect, in some cases, resulting from the employment of certain chemicals with which the fluid may be charged.

It is often desirable to charge fluids which issue, or are discharged, from a source having a grounded connection and, under such conditions, unless proper means are employed, the fluid can carry no appreciable charge. By means which I have employed the fluid may be charged by influence, or induction, in which case it may, or may not, have a grounded source, as the nature of the case may require.

This application is a continuation of my application, Serial No. 482599, filed March 10, 1909, and entitled Electric treatment of vegetation.

In the drawings I have shown forms of apparatus which may be employed in carrying out my invention and which are now preferred by me.

Figure 1 is a form of device, shown partly in sectional elevation, which is actuated by the fluid discharge.

Fig. 2 shows certain features as added to the device shown in Fig. 1.

Fig. 3 shows a form of apparatus, partly in section, by means of which a fluid may be charged with electricity supplied from any convenient independent source.

Fig. 4 shows a type of deflector which may be applied in combination with the form of device shown in Fig. 3.

Fig. 5 is an elevation and partial section of a type of device operating under the principles of an ordinary dynamic generator.

Fig. 6 shows an upper plan view of certain parts of the device shown in Fig. 5.

Fig. 7 shows modified forms of charging terminal and discharging device.

Fig. 8 is a section on line 8—8 of Fig. 5.

It has been found, as a result of scientific experiments, that water and other fluids may, when discharged as a spray, be charged with electricity, and it is generally recognized that electricity properly applied, has a beneficial and stimulating effect upon vegetation.

I have conceived the idea of charging water used to spray, or water, vegetation with electricity, whereby the vegetation so treated will be stimulated and its growth and physical condition and vigor be improved.

I also contemplate that the water may, when desired, be charged chemically with such substances as have been found to have a beneficial effect, either in stimulating plant growth, or by way of having an injurious effect upon the fungous or insect pests to which the vegetation may be subject.

By the employment of chemicals I am also enabled to increase the potential of a charge carried by the fluid, and by adding the electrical charge to the chemically charged fluid, the chemical action is increased.

By these means, either separately or combined, as may best fit the occasion, I am enabled to stimulate the growth of vegetation or free it of pests, or to do both at once.

In Fig. 1 I have shown a form of apparatus in which the fluid in being discharged, impinges upon a deflector, or similar device, which also acts as a motor and is operatively connected with an electric generator, the

product of which is transferred to the escaping fluid by which it is applied to the vegetation, or other object, along with the fluid.

In the practice of my invention the fluid may be supplied from any convenient source and while, in some cases, it might be desirable to use a source wholly insulated from a ground connection, I also contemplate that the source may be uninsulated from the ground connection, as, for instance, an ordinary hose connection with a water main.

Where it is desirable to use an insulated source, an insulated tank and conduit may be employed to deliver the fluid and the tank insulated from its source of fluid supply during the operation of the charging device.

In the device as shown in Fig. 1, the pipe 19 conveys the fluid to the discharging device 4, which breaks it up into a number of jets. This consists of a chamber closed at the top, but provided with discharge openings 40. Supported above the discharge chamber 4, in position to be engaged by the fluid discharge, is a deflector 6, which also functions as an impulse or impact motor. This deflector, as shown, consists of a cone having angularly disposed vanes 60, projecting from its surface in such position as to be engaged by the fluid discharge to thereby rotate the whole. This deflector may be of insulating material or not and of any convenient and suitable form, as the case may require. In this form of generator the essential thing is to use a device which is both a deflector and a power generator, so that the fluid acting upon it, operates the generator. Provisions for axial adjustment may be provided, as a set screw 11.

In this form of device the deflector is mounted to turn on an insulating sleeve, or stem 7, or is in other ways electrically insulated from the chamber 4, and the pipes supplying the fluid. Preferably, this deflector is also insulated from the generating device, which result I have shown as being secured by mounting it upon a sleeve 9 of any suitable insulating material. These two parts are secured to turn together.

A metallic sleeve 10 is secured to turn with the sleeve 9 and the deflector, and preferably is provided with a depending petticoat 100, or such other construction as may best serve as a discharging terminal for electrically charging the escaping fluid. The upper portion of the sleeve 10 is secured to the disk 14 through which means the latter is made to rotate with the deflector 6.

A current collecting device, herein shown as a comb 12, is mounted adjacent the disk at one side and a similar device 13 on the same side but distant from its companion comb. The comb 12 is in electrical contact with the sleeve 10 and through this with the discharge terminal 100. The comb 13 is insulated from the other comb and is in electrical connection with the spindle 8, which extends within the sleeve 7, and through which it may be grounded. As the discharged fluid forms into spray in the inducing field of the terminal 100 it receives an induced or bound charge which it may carry and deliver to an object at a distance from the charging device.

Under certain conditions the fluid, instead of receiving its charge by induction, may be charged by contact with the charging terminal. Where this is desired to be brought about the deflector is so formed and positioned that the fluid has freedom of contact with the terminal.

The electrical generator above described is preferably inclosed within a box, or casing, 17, to which the spindle 8 is preferably connected at its upper end through the insulating bolts, or screws, 3 and 30. These bolts, for which other means of an insulating character may be substituted, also secure other parts of the device. Within this casing and adjacent the rotatable disk 14, is the stationary disk 16 which constitutes a part of the generator. This disk 16 is of glass or other material having like electrical qualities, as is also disk 14. There are other details of a generator of this sort which I have not shown but which are recognized as being associated with such machines and forming component parts thereof.

In Fig. 2 I have shown how magnets may be associated with the foregoing described generator to overcome certain conditions, including in some cases atmospheric conditions, and to otherwise increase the effectiveness of the generator. This result may be accomplished by so positioning and securing the magnets 15 and 18 that their fields of force are cut by the rotating disk 14 and its armature and necessary associated parts. These means may also be associated with other generators of similar character, depending on the results to be obtained.

In Fig. 3 I have shown a form of device by means of which the fluid may be charged with electricity delivered from any convenient source, through conductor 80. This source may be of high frequency character and the supply may be developed in any convenient manner. The terminal 2 receives the inducing charges through the conducting stem which is insulated from the discharging device by the sleeve 70 which is snugly and adjustably fitted in the discharging device.

The chamber 4 is provided with discharge openings 40 which deliver the fluid in a path which is in the inducing field of the terminal 2. When desirable the terminal 2 may be coated or covered with such insulating material as has been found suitable for such purposes.

Fig. 4 shows how a deflector may be used in combination with the device shown in

Fig. 3. Its position may be adjusted as by set screw 11. If it is desired to charge the fluid by contact with the charging terminal the deflector may be so positioned as to make this possible.

Instead of the foregoing described device, I may employ such an electrical generator as that shown in Fig. 5. In this case the fluid is made to actuate a rotatable member which, preferably, is in the form of a turbine 62, which has angularly placed blades 63, upon which impinge jets issuing from openings 42 in plate 44, which forms part of the wall of chamber 41. The fluid is then discharged as a spray through the large orifices 43, through the field electrically charged from discharging terminals 20.

This member, turbine 62, for which may be substituted any other suitable means, has rigid connection as by shaft 64, with the permanent magnets 5 and 50, which are rotated with reference to the field coils 51. While I have shown the magnets 5 as being rotatable it is also possible to secure like results by rotating an armature in the field of permanent magnets.

The discharging terminals may be of any suitable form or construction. In cases where grounding a part of the charge is found to be necessary, any convenient means may be employed for the purpose. The part 70 forms part of a closed chamber which may be a pointed closed tube and adapted to be inserted in the ground. It may also partly form the upper part of a standard.

In Fig. 7 I have shown modified forms of charging terminal and discharging device. As the jets of fluid issue from the insulated chambered head 45 through openings 40 they receive a charge from the annular charging terminal 21 which receives its charge from any convenient source of static charge 66. Though not entirely necessary, the head 45 is preferably made of earthenware or other insulating material and is adjustably supported by the supply pipe.

The foregoing constructions are shown and described in more or less rudimentary form and as instances of types of apparatus which may be employed and as illustrating the scope of my invention. It is evident that great variation in forms and construction of apparatus may be employed without departing from the spirit of my invention.

Where desired the charge may be supplied from an independent source and applied to charge a fluid as it is applied to the vegetation in the form of a stream.

Under different conditions different intensities and character of charge may be used and any suitable means employed to apply it, as for instance, such means as might include, or be associated with, a high frequency generator, or a transformer, or the like.

I have also found that an inducing charge alone may be employed to form a fluid into spray. I have found that where a jet of fluid issues under the influence of an inducing field of force the charge has the effect of forming the fluid into spray. This effect may be used either alone or in combination with deflecting means.

The inducing terminals described in the foregoing should be so formed that the induced charge delivered to the fluid is substantially the maximum charge capable of being delivered by the charging terminal. In other words, the form and construction is such that the fluid receives a charge from that surface, or part, of the inducing terminal which is capable of delivering the most effective charge. Where a convective charge is employed the form of the terminal may be modified to meet the requirements.

It is evident that with my invention various fluids may be electrically charged and the charged fluid applied in many different ways. It may also be used in electrostatic separation, and the like, and for purposes of atomization.

I contemplate using either relatively pure or chemically charged liquids with this device. By chemically charging the liquids an insecticide or a fungicide may be used. The effect of the electrical charge upon the chemical, it is believed, will intensify its action.

What I claim as my invention is:

1. The combination with a liquid discharging device of means actuated by said discharge to electrify the liquid discharged.

2. The combination with a liquid discharging device of a generator of electric charge actuated by the liquid discharged and means for electrically charging the discharged liquid from said generator.

3. The combination with a liquid discharging device of a rotary electric generator and means for electrically charging the liquid discharged from said liquid discharging device.

4. The combination with a liquid discharging device of means actuated by the discharged liquid to generate an electric charge and means for applying the electricity thus generated to induce a charge in the discharged liquid.

5. The combination with a device for discharging fluid upon vegetation, of a generator of electromotive force operated by the discharge of the fluid and connected to electrically charge the discharged fluid.

6. The combination with a fluid discharging device, of a rotatable deflector actuated by the discharge of fluid, and an electric generating device operated by said deflector and feeding its charge into the fluid discharge.

7. The combination with a fluid discharging device, of a rotatable member actuated by the fluid discharge, a static electric gen-

erator having one part thereof turned by said member, said generator being connected to discharge the electricity generated thereby into the fluid discharge.

8. The combination with a fluid spraying device, of means for giving the spray a bound charge of electricity, said means including a rotatable electrically charged terminal in inductive relation with the fluid discharge.

9. The combination with a fluid discharging device and means for electrically charging the fluid, of means for generating electricity actuated by the fluid and connected with said fluid charging means.

10. A fluid supply having an uninsulated source, means for dispersing the fluid, and means without the path of the fluid for giving the particles of said fluid an electric charge.

11. An apparatus for electrically charging a fluid comprising a fluid conduit and a spray device supplied thereby and means for giving the fluid an electric charge through a dielectric as it is discharged in the form of spray.

12. A fluid spraying device comprising, a source of fluid, a spray producing member, a charging terminal disposed centrally of and adapted to inductively charge the spray, and means for charging said terminal.

13. A device for applying electric charges to a fluid spray comprising, a source of fluid, a spray forming device, means for inductively charging the particles of the spray, said means being insulated from the spray device.

14. A device for applying electric charges to a fluid spray comprising, an uninsulated source of fluid, a spray forming device, and means for applying electric charges to the particles of the spray through a dielectric.

15. A means for applying a bound electric charge to vegetation comprising, means for discharging a fluid in the form of spray, and means for inductively charging said fluid with electricity.

16. A device for electrically charging a fluid spray having a charge inducing member spaced at a distance from the path of the spray.

17. A fluid spraying device for electrically charging a fluid spray having a member which is spaced from and adapted to form a field of force in the path of the fluid spray.

18. A device for electrically treating vegetation comprising a spray device having means for electrically charging the spray through a dielectric.

19. As an article of manufacture, a device for electrically charging fluid vapor or spray including an uninsulated source of fluid and means for projecting a field of force into the path of the fluid.

Signed at Seattle, Washington, this 19th day of October, 1916.

EDGAR EARLE LITTLEFIELD.

Dec. 4, 1923.

1057

1,475,995

L. HEIS ET AL

CHEMICAL CONVERSION OF SUBSTANCES

Filed March 21, 1923 2 Sheets-Sheet 1

Fig. 1

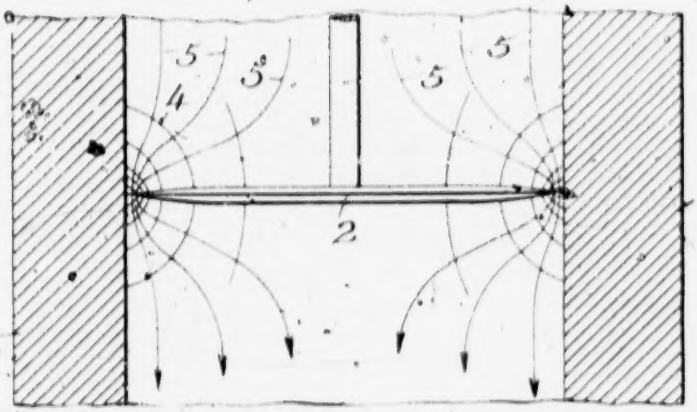


Fig. 2

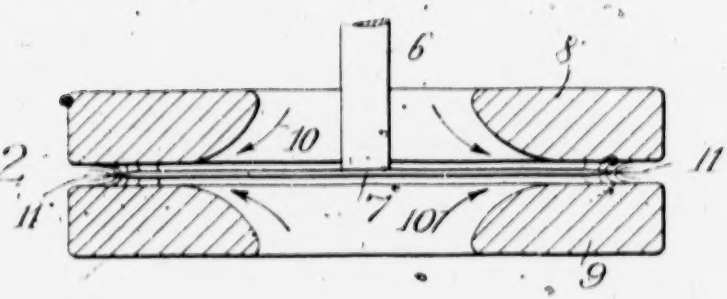
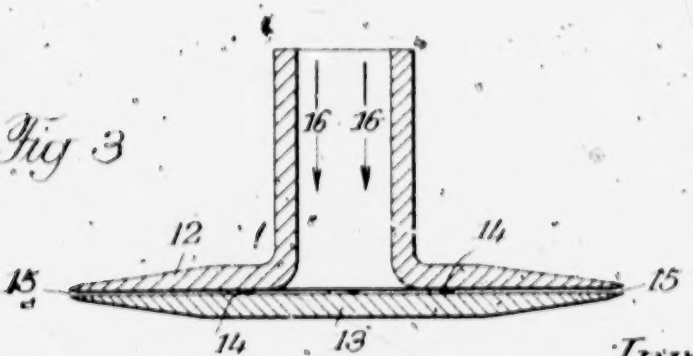


Fig 3



Inventors:

Leonhard Heis.

Hubert Jeyler

By [illegible]

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Dec. 4, 1923. 1,475,995

L. HEIS ET AL

CHEMICAL CONVERSION OF SUBSTANCES

Filed March 21, 1923 2 Sheets-Sheet 2

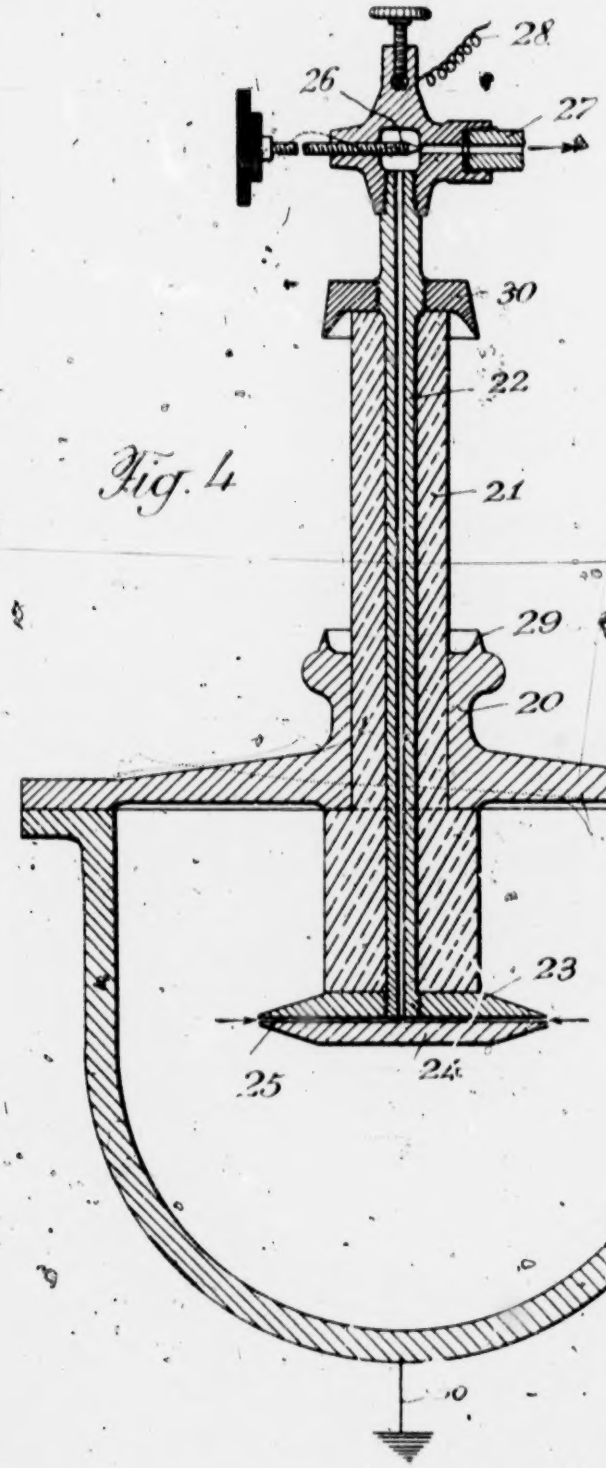
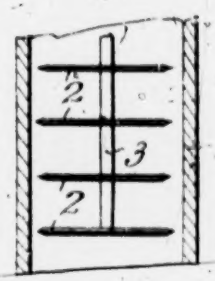


Fig. 4

Fig. 5



Inventors
Leonhard Heis
Herbert Jezler
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Attys

Patented Dec. 4, 1923. 1,475,995

1061

UNITED STATES PATENT OFFICE.

LEONHARD HEIS AND HUBERT JEZLER, OF ZURICH, SWITZERLAND.

CHEMICAL CONVERSION OF SUBSTANCES.

Application filed March 21, 1923. Serial No. 626,658.

To all whom it may concern:

Be it known that we, LEONHARD HEIS, a citizen of the Republic of Germany, residing at Zurich, Switzerland, and HUBERT JEZLER, a citizen of the Republic of Switzerland, residing at Zurich, Switzerland, have invented certain new and useful Improvements in the Chemical Conversion of Substances; and we do hereby declare the following to be a clear, full, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same, reference being had to the accompanying drawings, and to letters or figures of reference marked thereon, which form a part of this specification.

Numerous apparatus exist already intended for the chemical conversion of especially gaseous and vaporous substances by means of an electric discharge. Generally the substances to be converted i. e., chemical actions to be produced are, between the electrodes of such apparatus, subjected to the action of an electric current in the form of an electric arc, sparks, brush-light, glow-light and cold discharges, the chemical conversion being effected by shock ionization. In order to cause the required electric energy to act on a great many molecules it is necessary with these processes to cause the substances to travel a long stretch between the electrodes. The practical application of these processes yields, however, insufficient results in most cases.

In contradistinction to the hitherto known processes with the process according to the present invention the substances to be converted are caused to pass through very intense electric fields without producing the disruptive or discharge phenomena above described, and having an intensity of at least 10^3–10^5 volt per centimetre which fields are obtained by the utilization of high tension currents or by the combined utilization of such currents and of steam or gas pressures up to thousands of atmospheres, whereby the temperature of the substances is variable within wide limits.

The intense electric fields may further be produced at the intensely curved surface of electric conductors, such as for instance points, edges, or thin wires, by charging these conductors with high tension current. With such fields and for the conversion of some substances pressures of for instance 20, 100 and more atmospheres may be found sufficient.

Most of the modern physicists favour the view that the binding forces within the atoms and the molecules are of an electric nature. It must therefore be possible to effect dissociations when electric forces are utilized which are sufficiently powerful. There are numerous indications to be found in the modern technical literature about the order of magnitude of these forces.

When working at atmospheric pressure the generation of the necessary electrostatic intensity of field can be frustrated by the fact, that with comparatively small intensities of field shock ionization is initiated by the action of the ions which are always present to a certain degree, this shock ionization may prevent a further considerable increase in the intensity of field. The intensity of field at which the shock ionization starts depends on the pressure of the gas and is in proportion to said pressure. This intensity of field is with air under atmospheric pressure approximately $2–5.10^4$ volt/cm. On the other hand the intensity of field which is necessary for the direct cessation of the molecular binding forces is independent of the density of the gas and amounts, for instance to 10^5 volt/cm. with nitrogen. In order to attain this intensity of field it may be found necessary to work at such pneumatic pressures that the shock ionization only occurs when this intensity of the field is reached. The pneumatic pressure required for treating air and nitrogen amounts to approximately 10^2 atmospheres. Experiments have borne out this conclusion and have shown that with an increasing pneumatic pressure a continuously increasing quantity of the gas is rendered active and that at a determined pressure, i. e., at the pressure at which the shock ionization is approximately completely suppressed, the highest output of active gas is obtained.

The largest electrostatic forces are present in the immediate neighbourhood of the surface of intensively curved conductors which are charged with electricity, for instance at points, along edges and around thin wires. By suitably shaping the surface of the conductor as well as by choosing the tension,

the intensity of these fields may be altered at will. The height of the tension is limited or controlled in practice by a suitable increase of the curvature of the surface, however, the fields may be so chosen that their action overcomes wholly or partially the chemical binding forces. If the fields can be made sufficiently intense, a very small space is obtained within which nearly all the molecules can be influenced. Only this small space shall be utilized according to the present invention.

Assuming as conductor a thin wire or one provided with a sharp edge and using the tension φ as ordinates and the distance s as abscissæ then the intensity of fields is—

$$\frac{d\varphi}{ds}$$

If such conductors are charged for instance with a current of approximately 500,000 volt or more, electric fields are generated in the immediate neighbourhood of these conductors showing an intensity of 10^8 volt/cm. and more, which intensity suffices to overcome many chemical binding forces. As the intensity of the field decreases very rapidly with an increase in the distance from the conductor it is evident that the effective space is very small and measures only a few millimetres or perhaps only fractions of a millimetre. Within this limited field the substance forced through it is acted upon only a very short time, as this small space is quickly transversed by the substance to be treated. The converted substances are thereupon not subjected to a further destruction in the weak field but they may act on each other unobstructedly. When the substance flows past edges, the whirls generated thereby may be utilized for mixing the separated components.

The shock ionization which acts in the same manner is not desired as it causes a good conductivity and thereby the formation of sparks, of glow- and brush-light and of cold discharges with the result of a temporary reduction in the intensity of the field whereby the uniformity of effective action and the desired result are reduced to a large extent.

The shock ionization may be prevented for the greatest part by forcing the substances to be treated—gases, vapors and dust suspensions and their mixtures, and hereinafter called gaseous substances—through a small passage, in which the field is most intense, at a suitable speed and eventually at a proper pressure, or by admixing to the medium to be treated, substances which lower effectively the electric conductivity but which do not necessarily partake in the chemical conversion. A further way of keeping the shock ionization within certain limits consists in the utilization of the electrical condensing action by the expansion of vaporous medium in the electric field.

The progress of the chemical conversion of the substances will approach the ideal state when for instance a circular disc having a sharp edge is continuously charged at high tension and is so mounted that near the disc no other body is present having a different potential and through which the electric current would flow off. Under this condition and making use of the above mentioned precautions for avoiding the shock ionization the conversion of the supplied electric energy into the equivalent chemical energy takes place continuously whereby the escape of free electricity from the field which would be a loss, is avoided.

In practice, however, this ideal state is only approximately attained, but the approximation goes so far that high concentrations of the converted substances are obtained without too great losses occurring.

Constructional examples of devices adapted to carry into effect the present process are illustrated in the accompanying drawings, in which Figs. 1–5 are vertical sections through five devices.

Referring to Fig. 1 of the drawings, 1 denotes a tubular insulator in which a circular disc 2 having a knife edge is located, the disc 2 being charged at high tension by means of a vertical rod 3. The cross-sectional area of the passage between the nonconductor 1 and the disc 2 is dimensioned of a greater or smaller width according to the required action of the electric field. But in any case this width must be small to obtain the greatest pressure of the gas at the constricted passage between the knife edge and the tube wall where the intense field is located. The electric field which is at the periphery of the disc 2 and the maximum intensity of which is in the immediate neighbourhood of the knife edge of the disc, is illustrated by the lines of force 4. The substances to be converted, which may be in a vaporous, gaseous and powdery state, i. e. suspended as dust, or in a mixture of these states, are forced to pass through the electric field in the direction of the arrows 5 at more or less high speeds and under high pressures.

Fig. 2 illustrates a constructional form of the device which is a modification of that shown in Fig. 1. The knife edged plate 2 shown in Fig. 1 is replaced by a thin sheet metal disc 7, which is charged at high tension by the conductor 6.

The conductive disc 7 is arranged in a small space between two parallel discs 8 and 9 made of insulating material, which space corresponds to the effective portion of a field. The substance to be converted is forced in the direction of the arrows 10 through the high tension field 11 present at the edge of

the disc 7. The direction of flow of the substance may also be reversed if circumstances require it.

Fig. 3 shows a further constructional example of a device according to the invention which differs from the above described two examples inasmuch as two knife edged conductive discs 12 and 13 charged with electric current are utilized. The two discs are electrically connected to each other by means of intermediate pieces 14 or spacing blocks so that a very narrow space is obtained between the discs. The field is formed at the edges of the discs, at 15, and gases which are forced in the direction of the arrows 16 through the tubular extension of the disc 12 have to pass through this field.

Fig. 4 shows the whole arrangement of an apparatus for the chemical conversion of substances. The substance to be treated is supplied to the apparatus which is of metal through the branch 17 of a receptacle 18. The receptacle is closed by a cover 19 having a cylindrical extension 20 through which an insulated member 21 passes. The member 21 surrounds a tube 22 made of conductive material. The lower end of the tube 22 is screwed to a conductive disc 23 to which a disc 24 is fixed, a narrow space 25 being left between the discs for the substance to flow through. At the other end of the tube 22 a valve 26 is arranged by means of which the pressure inside the receptacle 18 can be regulated. The treated substances are discharged at 27. The top of the tube 22 is connected to a source of high tension current, for instance to a transformer by the lead 28, the receptacle 18 is grounded at 30. The top of the extension 20 is provided with a sharp edged flange 29 and above the insulated member 21 there is arranged a metallic cap 30 having a similar sharp edged flange, the flanges forming between them a safety sparking gap.

The two knife edged discs may be substituted by two discs made of thin sheet metal, or more than two discs may be used, (for instance four as shown in Fig. 5) to suit special practical requirements.

With the last described arrangement very small areas for the passage of the substance are obtained without the utilization of non-conductive protecting discs 8 and 9, as shown in Fig. 2.

It is evident that a great many constructional forms of the devices according to the invention can be made and that instead of discs other bodies made of wires such as wire nettings, spirals, sharp points and the like may be used for generating the fields through which the substances to be treated have to pass.

In Figs. 1–3 only the field producing elements of the device are illustrated, numbers of such elements may of course be assembled to form an apparatus as required in practice, and as is shown in Fig. 5.

The present invention is of particular importance for the production of nitrogenous compounds from the air whereby air is forced through the devices described above and the nitrogen molecules are dissociated, i. e. are rendered active; however, the invention may be applied to any other substances in vaporous or gaseous condition or suspended as dust.

The substances to be treated may be forced through the fields at varying initial and final pressures and at varying speeds for which more or less narrow areas for the substances to pass may be chosen according to the effective portion of the field. The substances may also be forced from nozzles as free jets through the electric fields.

With some chemical products it is advantageous to let the converted substances mix with each other only after they have passed the electric fields.

The treatment of the substances may also take place at high temperatures, in this case the most suitable temperatures at which the conversions may be effected will have to be carried out by experiments in every case.

We claim:

1. The process of effecting chemical action of substances that are in a gaseous or vaporous state or in suspension, which comprises forcing the substances to be treated through a high tension electrical field without causing shock ionization and rupture of said field.

2. The process of effecting chemical action of substantially gaseous substances or suspensions, which comprises producing an electric field of not less than 10 volts per cm. and forcing the substance to be treated through such field without causing shock ionization and rupture of said field.

3. The process of effecting chemical action of substantially gaseous substances, which comprises producing a small electric field of a tension between 10^3 and 10^8 volts per cm., and forcing such substance through said small field under a pressure considerably above atmospheric pressure without producing shock ionization and a disruptive discharge of said field.

4. The process of effecting chemical action, which comprises forming at the acutely curved surface of an electric conductor a static electrical field of high tension, and passing the substances to be treated through such field at a pressure and temperature that will not cause shock ionization and a rupture of said field.

5. The process of effecting chemical action, which comprises generating a high tension electrical field, subjecting the substance to be treated to the action of such field without discharging the field to produce

shock ionization, and maintaining a high pressure on the substance during its passage through the field.

6. The process of effecting chemical action, which comprises maintaining a high tension electrical field without producing shock ionization at an acutely bent conducting surface, and crowding the substance to be treated through a narrow space in such field at a high pressure without discharging said field.

7. The process of effecting chemical action, which comprises maintaining a high tension electrical field without producing shock ionization at an acutely bent conducting surface, and crowding the substance to be treated through a narrow space in such field at a high pressure and at a high temperature without rupture or discharge of said field.

8. The process of effecting chemical action, which comprises imparting a high pressure to the substance to be treated, maintaining at an acutely curved conducting surface a very intense electrical field without producing shock ionization, the electrical tension and curvature of said surface being chosen to maintain a field between 10^5 and 10^8 volts per cm., and maintaining the high pressure on the substance while in said field without causing rupture of said field.

9. The process of effecting chemical action of substantially gaseous substances, which comprises forcing such substance to be treated through a high tension electrical field without causing shock ionization or a rupture of said field, and mixing with such substance a medium capable of lowering the electric conductivity of said substance.

10. The process of effecting chemical action of substantially gaseous substances, which comprises forcing such substance through a high tension electric field without causing shock ionization or rupture of said field, mixing with such substance a medium capable of lowering the electric conductivity of the substance, and maintaining a high pressure on the mixture while in such high tension field.

11. The process of effecting chemical action of substantially gaseous substances, which comprises forcing such substances through a constricted passage in a high tension electrical field without causing shock ionization and thereby imparting whirls to such substances to mix the components of such substances, and controlling the initial and end pressures of the substance to determine the speed of passage through such field.

12. The process of effecting chemical action of substantially gaseous substances, which comprises imparting a high pressure to the substances to be treated, forcing the substances under said high pressure through very intense electric fields formed at the acutely curved surface of electric conductors, thereby causing the condensing action produced by the expansion of vaporous substances to reduce shock-ionization, and controlling the temperature of the substance to be treated.

13. The process of effecting chemical action of substantially gaseous substances, which comprises imparting a high pressure to the substances to be treated, forcing each substance separately under high pressure through very intense electric fields formed on the acutely curved surface of electric conductors without producing shock ionization, and causing the substances leaving said electric fields to mix and react with each other.

14. A device for effecting chemical action of substantially gaseous substances, comprising a plurality of elements each consisting of a conductor having an acutely curved surface, means to charge said elements with high tension current, and means to conduct the substances to be treated through the electric fields without producing shock ionization at the acutely curved surfaces of said elements.

15. A device for effecting chemical action of substantially gaseous substances, comprising a plurality of elements each consisting of a disc of conductive material provided with a knife-edged circumference, means to charge said elements with high tension current, and means to conduct the substances to be treated through the electric fields at the acutely curved surfaces of said elements, without producing shock ionization.

16. A device for effecting chemical action of substantially gaseous substances, comprising a plurality of elements, each consisting of a conductor having an acutely curved surface, means to charge said elements with high tension current, means to conduct the substances to be treated through the electric fields generated at the acutely curved surfaces of said elements, and means to limit the area for the passage of the substances to the most effective parts of the field without producing shock ionization.

17. A device for effecting chemical action, comprising an electrical conductor having an acutely curved surface, means to charge said conductor at high potential to form an electrical field of increased potential at the acutely curved surface without effecting shock ionization, and means to direct through such field in a constricted passage thereat the gaseous substance to be treated under substantially high pressure.

18. A device for effecting chemical action, comprising a closed chamber having an inlet for the material under pressure, an electrode comprising spaced electrode elements arranged to form a narrow slot between them, a tube extending from said electrode

and slot, and means to supply current to the electrode to produce a substantially non-disruptive electrical field at the edges of the electrode and slot.

19. A device for effecting chemical action, comprising a closed, grounded chamber having an inlet for the material under pressure, an electrode comprising electrode elements arranged to form a narrow slot between them, a conductive tube passing into said chamber and perpendicular to said electrode and slot for the exit of products formed, a valve to control said tube, and an electric terminal for the tube.

In testimony that we claim the foregoing as our invention, we have signed our names.

LEONHARD HEIS.
HUBERT JEZLER.

1067

April 19, 1932. E E LITTLEFIELD 1,854,475

METHOD FOR ELECTRICALLY CHARGING FLUIDS

Filed Nov. 27, 1920

Fig. 1

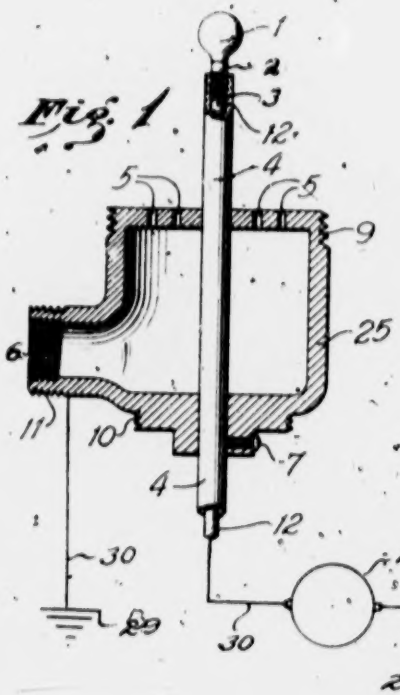


Fig. 2

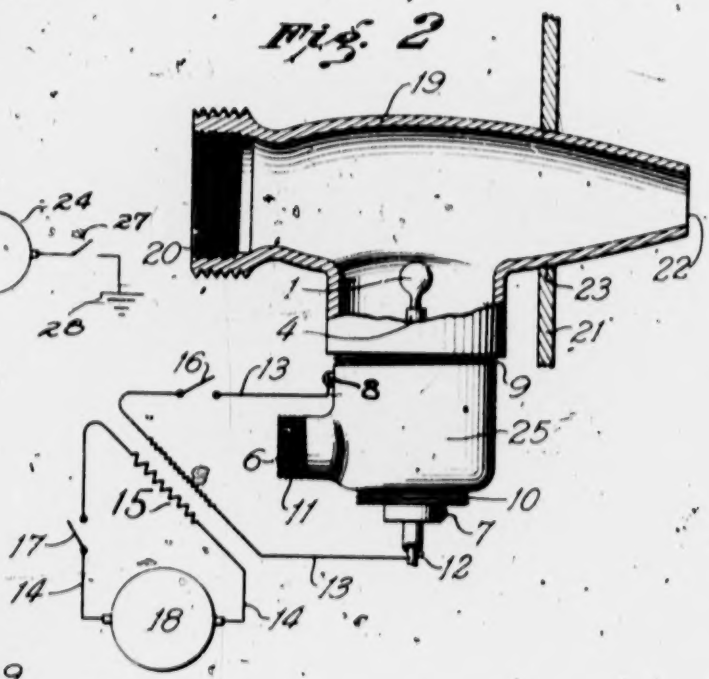
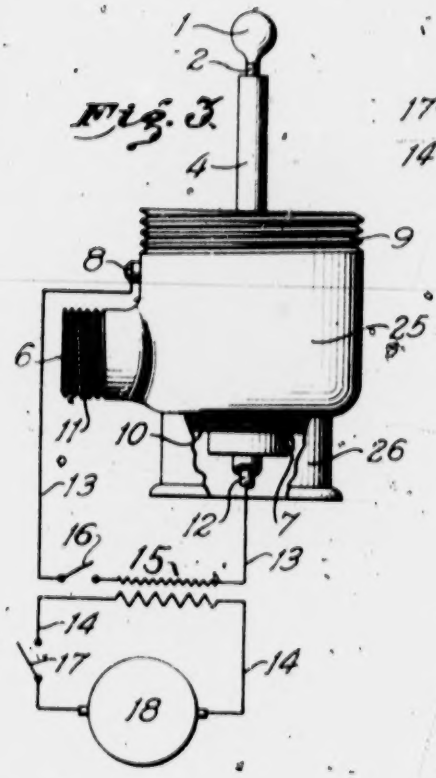


Fig. 3



INVENTOR

Edgar Eugene Littlefield

Patented Apr. 19, 1932

1,854,475

1069

UNITED STATES PATENT OFFICE

EDGAR EARLE LITTLEFIELD, OF SEATTLE, WASHINGTON

METHOD FOR ELECTRICALLY CHARGING FLUIDS

Application filed November 27, 1920. Serial No. 426,860.

This application is a continuation, in part, of an application filed by me October 24, 1916, Ser. No. 127,338, for an improvement in apparatus for electrically charging fluids, which application eventuated in Patent No. 1,360,654, Nov. 30, 1920. The application which eventuated in Patent No. 1,360,654, is a continuation of my former application filed March 10, 1909, Ser. No. 482,599, and the subject-matter of the instant application is disclosed in the application filed March 10, 1909.

My invention relates to methods of electrically charging and treating fluid vapors and sprays and to apparatus for putting such methods into practical use.

One of the objects of my invention is to provide a means and method for dispersing fluids, particularly fluid fuels.

Other and further objects and advantages of the invention will appear to those skilled in the art upon consideration of the specification, drawings, and the appended claims.

For a better understanding of the nature and scope of my invention reference may be had to the following description and the accompanying drawings in which Figure 1 is a side elevation, partly in section, of one embodiment of my invention. Fig. 2 is a diagrammatic view, partly in sectional elevation, showing a circuit arrangement and one application of the invention. Fig. 3 is a diagrammatic view showing the device of Fig. 1 connected to a source of current, together with other details.

I have found that a fluid may be reduced to the form of vapor or spray by subjecting the same to an inducing electrical field. I have found that where a jet of fluid issues under the influence of an inducing field of force the charge has the effect of forming the fluid into fine particles. This effect may be used either alone or in combination with deflecting means.

While it would be desirable in many cases to use the fluid in a comparatively purer state I contemplate that advantage may be taken of the increased effect in some cases resulting from the employment of certain chemicals with which the fluid may be charged. By the employment of chemicals I am enabled to increase the potential of a charge carried by the fluid.

I have employed this method to disperse fluids employed in the electrical treatment of vegetation. I have also employed the method to disperse, or atomize, liquid fuel employed in connection with furnaces and internal combustion engines. It has also been used for charging and dispersing fluids discharged from fountains.

As a further illustration of the scope of the invention it may be utilized for the generation of ozone to be supplied to the fuel using device. Instead of opposing combustion, this substance has been found to possess properties favoring it.

In Fig. 1 I have shown an embodiment by means of which the fluid may be dispersed by subjecting it to the influence of an electrostatic field. To this end I have provided a casing 25, which may be connected to a source of fluid by means of the screw threads 11 or 6. Fluid is discharged from the chamber provided by the casing 25 through the discharge openings 5, 5 in a path which is in the inducing field of an electrode 1, which is connected by means of a threaded member 3, and a conductor 12, to a source of high tension electricity. The conductor connecting the electrode with the source of electricity is preferably enclosed within an insulating member 4, while its position, together with that of the electrode, may be adjusted by means of set screw 7. At 2 is an insulating sleeve enclosing the conducting member and a part of the electrode. The electrode 1 may of a type commonly used with violet ray machines, or the like. I contemplate, however, that any other suitable type or form of electrode may be substituted therefor and either a part or the whole enclosed by insulation where necessary. Such means as might include, or be associated with, a high frequency generator, or a transformer, or the like, may be employed to develop an electrostatic field for charging the vapor or spray. While an inducing field developed by an alternating current may be employed to charge the fluid, I have found it preferable to employ unidirectional current. For this purpose either a mechanical

rectifier or a set of two, preferably four, kenotrons may be employed. With such apparatus both sides of the waves are made available for use. With one kenotron, however, one side of the waves is suppressed and one side made available. I have found that for dispersing the fluid unidirectional current is superior to alternating current. A simple arrangement for dispersing the fluid by means of unidirectional current may consist of a high potential generator of unidirectional current, conventionally shown at 24 which is connected by means of circuit 30 to conductor 12 and the device 25. Circuit 30 may, if desired, be provided with a switch element 27 and "grounded" at 28 and 29, or completed in any other suitable or convenient manner.

Theoretically considered and assuming that the conductor 12 is connected to a source of direct current an electrical field will form in the region adjacent the electrode 1. If the field is one in which induction may take place and fluid from a jet is discharged under the influence of the field the particles leaving the jet will carry electrical charges of one sign while the charges of the opposite sign will be given up to the jet, it being assumed that the electrostatic capacity of the jet is sufficient to absorb the charges of opposite sign. Since the particles leaving the jet carry electrical charges of similar sign mutual repulsion or dispersion results.

Considering now a field in which the air is ionized or charged, it is possible to charge the particles of fluid by means of the ionized air. If the fluid particles, for instance, are exposed to contact with the ionized air electrical charges will be imparted to the former. Since the charges carried by the air particles are of similar sign and these are shared with the particles of fluid the charges imparted to the latter will be of similar sign.

In the foregoing it has been assumed that the field is one produced by direct current. If now a field produced by alternating current is substituted for the former similar results may be obtained. An insulated particle of matter occupying a fixed position in an alternating field will receive first a charge of one sign and then a charge of opposite sign, but if the particle is passed rapidly through the field it will be found to possess a substantial charge after leaving the field. Obviously, the particle receives a charge and leaves the field before an opposing influence is set up. In a substantially similar manner it is possible to charge particles of fluid or solid matter. Moreover, it is apparent that

In Fig. 2 I have shown an arrangement by means of which the method may be employed for dispersing or atomizing fluid fuel employed in connection with a furnace. This arrangement provides a burner 19, having an orifice 22 opening into the furnace chamber (not shown), and an air supply inlet which may be connected, if desirable, to a source of air under pressure by means of the screw threads 20. The burner is connected to the wall 21 of the furnace by means of the screw threads 23. By means of the screw threads 9 a combination is effected between the device of Fig. 1 and the burner 19. A low tension source of current 18 supplies current through circuit 14 to the primary winding of a high tension transformer 15, which, in turn, feeds the secondary circuit 13, which is connected to terminal 8 and conductor 12. Means are provided for opening or closing circuits 13 and 14 by the switch elements 16 and 17 respectively.

Figure 3 is a diagrammatic view of a side elevation of the device of Fig. 1, showing the same connected to a standard, and also showing the circuit connections, the same being as before described. As illustrated, the standard 26 is connected by means of the screw threads 10 to the casing 25. The standard, which is shown partly in section, provides a supporting means whereby the device may be employed in electrical irrigation. Obviously, any other suitable or convenient means may be substituted for the standard shown and connected, as by the screw threads, to the casing 25. The device may also be supported by the conduit supplying the fluid, in which case the standard would be unnecessary.

I contemplate that water, when applied to vegetation, may, when desired, be charged chemically with such substances as have been found to have a beneficial effect, either in stimulating plant growth or by way of having an injurious effect upon the fungus or insect pests to which the vegetation may be subject. By adding the electrical charge to the chemically charged fluid the chemical action is increased. By these means, either separately or combined, as may best fit the occasion, I am enabled to stimulate the growth of vegetation or free it of pests, or to do both at once.

It is evident that with my invention various fluids may be electrically charged and the charged fluid applied in many different ways. As indicated previously, either relatively pure or chemically charged liquids may be used with this device.

without departing from the scope of the appended claims.

What I claim is:

1. The method of dispersing fluid fuel which consists in discharging the same in the form of one or more jets and applying electrical charges to the dispersed particles of similar sign and substantially equal value.

2. The method of reducing fluid fuel to a form suitable for consumption which consists of applying thereto electrical charges of such character as to cause repulsion between the particles.

3. The method of dispersing particles of fuel which consists in applying thereto mutually repellent electrical charges.

4. The method of dispersing fluid fuel which consists in discharging the same in the form of one or more jets and so charging the unvaporized fluid that when the particles become detached from the mass they carry electrical charges of such character that mutual repulsion is produced between them.

5. The method of dispersing liquid fuel which consists in applying to the particles thereof electrical charges of similar sign and of substantially equal value.

6. The method of dispersing a liquid which consists in applying mutually repellent electrical charges to the particles thereof.

7. The method of dispersing liquid fuel which consists in applying bound electrical charges of similar sign to the particles thereof.

8. The method of reducing fluid fuel from an undispersed condition to a dispersed condition which consists in so charging the particles thereof that when they are caused to move in a path that those particles cutting the same cross-sectional plane at the same time carry electrical charges of such character that the force exerted by mutual repulsion is of substantially equal value between them.

9. The method of dispersing liquid fuel which consists in projecting into the path thereof an electrical field of such character that after the particles leave the field they carry mutually repellent electrical charges.

10. The method of dispersing liquid fuel which consists in projecting into the path thereof a unidirectional high potential electrical field of such character as to cause mutual repulsion between the particles of the fuel.

11. The method of dispersing liquid fuel which consists in projecting into the path thereof a high potential [illegible]

carry mutually repellent electrical charges of substantially equal value.

13. The step in the method of dispersing liquid fuel which consists in so charging the particles that those traveling abreast carry electrical charges of like sign.

14. The method of dispersing liquid fuel which consists in applying to the particles thereof electrical charges of such character that mutual repulsion is produced independently of ionization.

15. The method of reducing liquid fuel from an undispersed condition to a dispersed condition which consists in so charging the particles that they carry electrical charges of one sign while the electrical charges of opposite sign are given up to the undispersed body of the liquid.

16. The method of dispersing liquid fuel which consists in causing mutual repulsion between the particles thereof without simultaneously causing precipitation of the same.

17. The method of dispersing a fluid which consists in establishing an electrical field and discharging the fluid in the form of two or more jets into the field to apply electrical charges to the dispersed particles of similar sign and substantially equal value.

18. The method of dispersing a fuel fluid consisting in establishing a uni-directional electrical field in confined gas, and spraying fuel liquid to commingle with the gas and to pass through the electrical field to impose a charge of like sign on the spray particles to effect mutual repulsion between the same to augment the dispersion of the same.

In testimony whereof I have hereunto affixed my signature at Seattle, Washington, this 20th day of November, 1920.

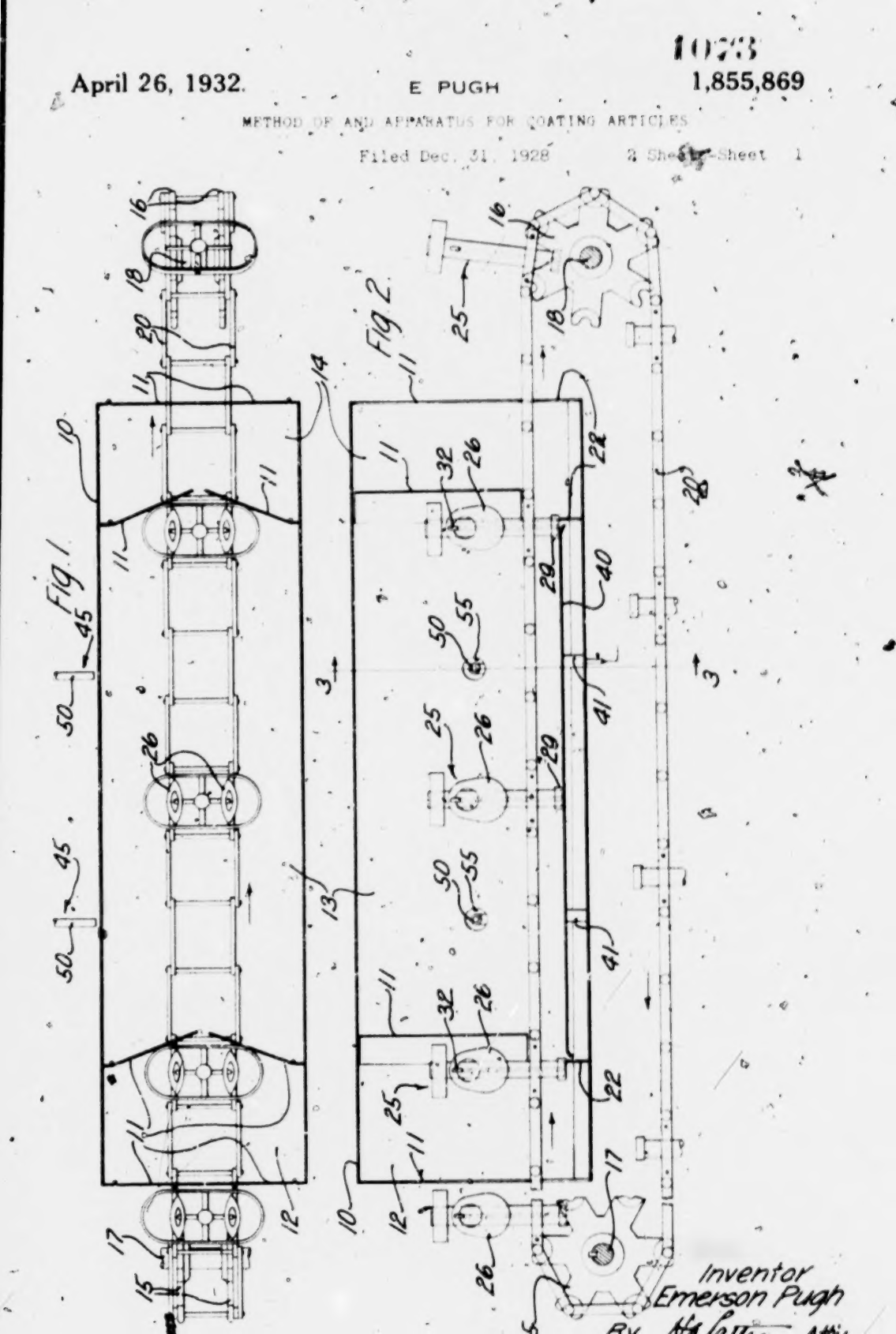
EDGAR EARLE LITTLEFIELD.

1073

April 26, 1932. E PUGH 1,855,869

METHOD OF AND APPARATUS FOR COATING ARTICLES

Filed Dec. 31, 1928 2 Sheets-Sheet 1



April 26, 1932. E PUGH 1,855,869

METHOD OF AND APPARATUS FOR COATING ARTICLES

Filed Dec. 31, 1928 2 Sheets-Sheet

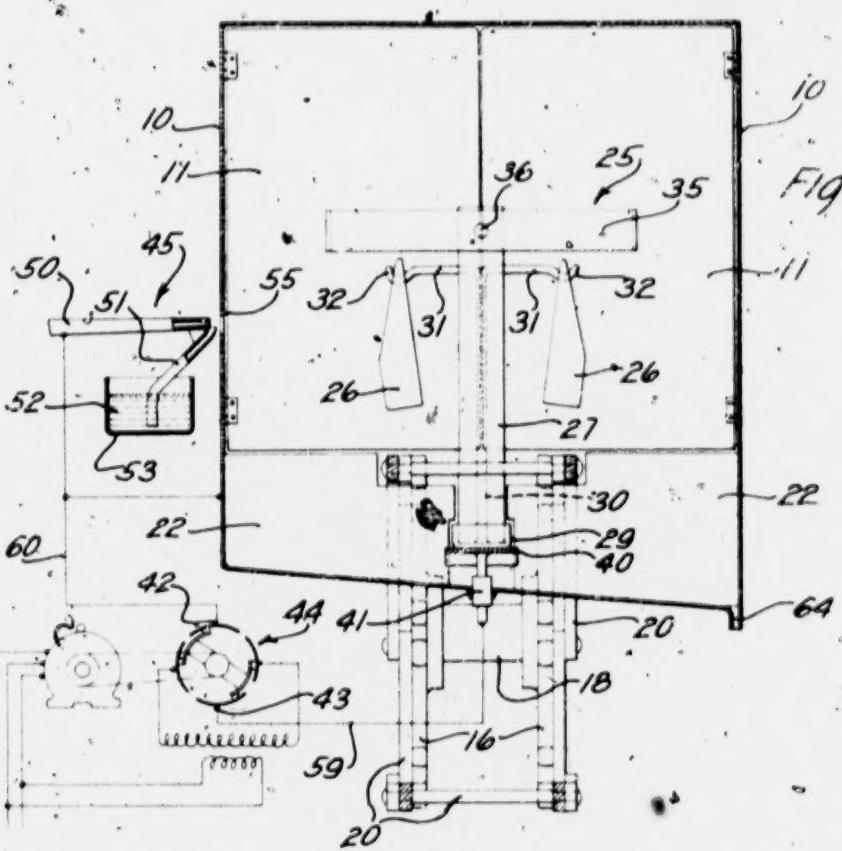


Fig. 3

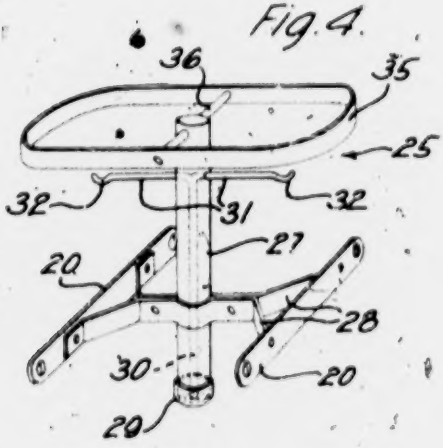


Fig. 4

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UNITED STATES PATENT OFFICE

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METHOD OF AND APPARATUS FOR COATING ARTICLES

Application filed December 31, 1928. Serial No. 329,393.

This invention relates to methods of and apparatus for coating articles, and more particularly to methods of and apparatus for finishing metal parts.

The principal objects of the invention are to provide a simple and expeditious method of and apparatus for applying material uniformly to exposed surfaces of articles.

In order to accomplish these objects in accordance with the invention, one embodiment thereof contemplates the conveying of metal parts or other articles to be coated through a closed chamber, the parts on the conveyor being connected in their passage therethrough to one terminal of a source of electrical energy of high potential. The opposite terminal of this source is connected to a nozzle through which an atomized spray of coating material is introduced into the chamber, thus giving the particles of the coating material suspended in the atmosphere of the chamber a charge opposite to that of the metal parts. These particles are thus selectively attracted to the uncoated portions of the parts in preference to the portions already covered by the solvent of the japan or other coating material so that they are deposited upon the uncoated surfaces thereof. To prevent the undue deposition of particles of coating material upon the interior of the chamber, the chamber wall is connected to the source of electrical energy so that it has the same potential as the nozzle.

It is believed that a complete understanding of the invention may be had from the following detailed description, taken in conjunction with the accompanying drawings, in which

Fig. 1 is a fragmentary plan view of an apparatus embodying features of the invention and which may be employed in practicing the method;

Fig. 2 is a front elevational view thereof with the front wall of the chamber removed;

Fig. 3 is an enlarged sectional view taken on line 3—3 of Fig. 2, showing the electrical equipment associated with the apparatus, and

Fig. 4 is an enlarged perspective view of one of the supports for carrying the parts to be coated.

Referring now to the drawings wherein the same reference numerals indicate similar parts throughout the various views, the numeral 10 designates a chamber made of sheet metal having four pairs of swinging doors 11—11 which are so mounted as to always return to a closed position. This arrangement divides the chamber into three compartments 12, 13 and 14 so that compartments 12 and 14 serve as air locks for the middle compartment 13. Partitions 22—22 (Fig. 3) are provided under each pair of swinging doors 11—11 to prevent the circulation of air between the compartments. At both ends of the chamber 10 are sprockets 15—15 and 16—16 suitably mounted on shafts 17 and 18, respectively, and adapted to engage operatively and support an endless sprocket chain 20 in its passage through the chamber. Secured to the chain at equal spaces throughout its length are supports 25 for carrying parts 26 to be coated.

Each of the supports 25 includes an insulator 27 rigidly held in an upright position by a pair of angular members 28—28 secured to the sides of the chain 20. A metal cap 29 secured to the lower end of the insulator 27 is connected to a metal rod 30 mounted in the center of the insulator and terminating near the upper end thereof in a pair of laterally extending arms 31—31 which are provided with hook portions 32—32 for supporting the parts 26 to be coated. At the upper end of the insulator 27 is a substantially rectangular guard 35 rigidly fastened thereto by a pin 36. This guard extends out beyond and surrounds the hook portions 32—32 so as to engage the swinging doors 11—11 and thus prevent injury to the parts 26 in their passage through the chamber.

A current conducting rail 40 for making contact with the metal caps 29 of the supports 25, is insulatively mounted on the bottom of the chamber 10 by means of insulating blocks 41—41 and is connected to the negative terminal 43 of a source of uni-directional electrical energy produced by a mechanical rectifier 44 (Fig. 3) from a source of alternating current (not shown). The positive terminal 42 of the rectifier 44 is connected to the walls of the chamber 10 and also to a plurality of atomizing devices 45 suitably mounted alongside the chamber, as illustrated in Figs. 1 and 3.

Each of the atomizing devices 45 comprises a nozzle 50 connected to a source of compressed air (not shown) and having its forward end attached to the upper end of a tube 51, the lower end of the tube being immersed in a liquified coating material 52, such as japan, lacquer, paint, etc., within a container 53. From the foregoing description it will be readily understood that upon compressed air being admitted to the nozzle 50, the emission of the air past the upper end of the tube 51 creates a vacuum therein whereby the liquefied coating material 52 is drawn up in the tube and the force of the air breaks the coating material into finely divided particles and blows it into the middle compartment 13 through apertures 55 in a wall of the chamber 10.

In practicing the invention, the shaft 17 is connected to and driven by any suitable source of power (not shown) so as to rotate the sprockets 15—15 keyed thereto and effect the movement of the sprocket chain 20 in the direction indicated by the arrows in Figs. 1 and 2. With the negative terminal 43 of the mechanical rectifier 44 connected to the current conducting rail 40 by a conductor 59, and the positive terminal 42 connected to the chamber 10 and the nozzle 50 by a conductor 60, the mechanical rectifier is operated to create a uni-directional current of high potential. The parts 26 to be coated are then placed on the hook portions 32—32 of the metal rods 30, and as the guards 35 engage and open the doors 11—11 in passing from compartment 12 into compartment 13 of the chamber 10, the metal caps 29 make contact with the current conducting rail 40. This contact connects the parts 26 to the negative terminal of the source of uni-directional electrical energy through laterally extending arms 31—31, metal rod and cap 30, 29, respectively, contact rail 40, and conductor 59 to the negative terminal 43 of the mechanical rectifier 44. As has been previously explained, the nozzle 50 of the atomizing device 45 is connected to a source of compressed air to effect the introduction of a coating material 52 in finely divided particles into the compartment 13. Since the atomizing device is connected to the positive terminal of the source of uni-directional electrical energy through nozzle 50, conductor 60 to the positive terminal 42 of the mechanical rectifier 44, the particles of coating material are given a positive charge as they emerge from the atomizing device 45 into the compartment 13 through apertures 55 in the chamber 10. The negatively charged parts 26 to be coated attract the positively charged particles of coating material so that the latter is deposited upon the surface of the parts 26 to form coatings thereon. A uniform coating of each part is assured, due to the fact that as the particles of the coating material are deposited thereon, the solvent of the coating material acts as a dielectric, whereby the positive charge is intensified at the uncoated spots on the parts 26 to better attract the particles of coating material thereto.

The difference of electrical potential between the parts 26 to be coated and the atomizing devices 45 can be varied greatly, depending on size of the chamber, the characteristics of the particular coating material used and the speed imparted to the conveying chain 20, but the voltage should not be of such a value as to cause arcs between the parts being coated and the atomizing devices or chamber walls. The connecting of the walls of the chamber 10 and the atomizing devices 45 to the same terminal of the source of uni-directional electrical energy produces positive charges on both the coating material 52 and the walls of the chamber 10 so that the particles of coating material are repelled from the walls to prevent undue deposition thereon. In order to carry off any excess coating material, the bottom of the chamber 10 is sloped toward a drain 64 (Fig. 3).

As the finished parts emerge from the chamber 10, they are removed from the supports 25 and uncoated parts are placed on the hook portions 32—32 and they in turn are carried through the chamber 10, so that the process is a continuous one.

It will be understood that the embodiment of the invention herein described and illustrated is merely a convenient and useful form of the invention which is capable of many other modifications without departing from the spirit and scope of the invention.

What is claimed is:

1. A method of applying a finish to an article of manufacture, consisting in finely dividing a coating material, surrounding the article of manufacture to be coated with an atmosphere having the finely divided material suspended therein, and subjecting the article of manufacture and the particles of the material to a difference of electrical potential to cause the material to be attracted to and deposited upon the article of manufacture.

2. A method of applying a finish to an article of manufacture, consisting in producing a uni-directional current of high voltage in an

atmosphere, introducing a coating material in a finely divided form into the atmosphere, and subjecting the article of manufacture to be coated to the current and the atmosphere for a predetermined period of time to cause electrical deposition of the material upon the article of manufacture.

3. A method of applying a finish to an article of manufacture, consisting in enclosing an article of manufacture to be coated, connecting a supply of coating material and the article of manufacture to be coated to opposite terminals of a source of uni-directional current of high voltage, introducing an atomized coating material into the enclosed atmosphere, and subjecting the enclosure to the same potential as the coating material to repel the particles of coating material therefrom as they are attracted and deposited upon the article of manufacture.

4. In an apparatus for applying a finish to an article of manufacture, a chamber for enclosing the article of manufacture to be coated, an air lock therefor, means for introducing into the chamber coating material in finely divided form, means for conveying the article of manufacture through the air lock into the chamber, means for connecting the article of manufacture for a predetermined period of time to one terminal of a source of uni-directional energy, and means for connecting the coating material to the opposite terminal of the source of electrical energy to cause the deposition of the coating material upon the article of manufacture.

5. In an apparatus for applying a finish to an article of manufacture, a closed chamber for receiving an article of manufacture to be coated, an atomizing device for introducing a spray of coating material into the chamber and a source of electrical energy associated with the chamber for subjecting the article of manufacture to one potential and the atomizing device and the chamber to an opposite potential to cause the deposition of the coating material upon the article of manufacture and prevent the deposition thereof upon the chamber wall.

6. In an apparatus for applying a finish to an article of manufacture, a chamber for enclosing the articles of manufacture to be coated, means for conveying the articles of manufacture therethrough at predetermined intervals, means for connecting the articles of manufacture to one terminal of a source of electrical energy at a predetermined time, an atomizing device for injecting particles of a coating material into the chamber, and means for connecting the atomizing device and the walls of the chamber to the opposite terminal of the source of electrical energy to repel the particles of coating material from the walls as they are attracted to and deposited upon the articles of manufacture.

7. A method of applying a finish to an article of manufacture consisting in enclosing a space of predetermined size, introducing into the enclosed atmosphere a coating material in a finely divided form, conveying the articles of manufacture to be coated through the enclosed atmosphere in spaced relation, and subjecting the articles of manufacture and the coating material to a difference of electrical potential to cause the coating material to be deposited on the articles of manufacture.

8. A method of supplying a finish to an article of manufacture consisting in enclosing an article of manufacture to be coated, connecting a supply of coating material and the article of manufacture to be coated to opposite terminals of a source of uni-directional current of high voltage, introducing an atomized coating material into the enclosed atmosphere, subjecting the enclosure to the same potential as the coating material to repel the particles of coating material therefrom as they are attracted and deposited upon the articles of manufacture, and imparting movement to the article of manufacture relative to the enclosure.

9. In an apparatus for applying a finish to an article of manufacture, a chamber for enclosing the articles of manufacture to be coated, a conveyor for moving the articles of manufacture therethrough at predetermined intervals, means carried by the conveyor for electrically connecting the articles of manufacture to one terminal of a source of electrical energy at a predetermined time, an atomizing device for injecting particles of a coating material into the chamber, and means for connecting the atomizing device and the walls of the chamber to the opposite terminal of the source of electrical energy to repel the particles of coating material from the walls as they are attracted to and deposited upon the articles of manufacture.

10. In an apparatus for applying a finish to an article of manufacture, a chamber for enclosing the articles of manufacture to be coated, a conveyor for moving the articles of manufacture therethrough at predetermined intervals, means carried by the conveyor for carrying the articles of manufacture, means for cooperating with said carrying means for electrically connecting the articles of manufacture to one terminal of a source of electrical energy at a predetermined time, an atomizing device for injecting particles of the coating material into the chamber, and means for connecting the atomizing device and the walls of the chamber to the opposite terminal of the source of electrical energy to repel the particles of coating material from the walls as they are attracted to and deposited upon the articles of manufacture.

11. A method of applying a finish to an article of manufacture, consisting in enclosing a space of predetermined size, introduc-

ing into the enclosed atmosphere a coating material in a finely divided form, conveying the article of manufacture to be coated through the enclosed atmosphere, and subjecting the article of manufacture and the coating material to a difference of electrical potential to cause the coating material to be deposited on the article of manufacture.

In witness whereof, I hereunto subscribe my name this 19th day of December, A. D. 1928.

EMERSON PUGH.

DISCLAIMER

1,855,869.—*Emerson Pugh*, Downers Grove, Ill. METHOD OF AND APPARATUS FOR COATING ARTICLES. Patent dated April 26, 1932. Disclaimer filed November 10, 1936, by the patentee; the assignee, *Western Electric Company, Inc.*, assenting and concurring.

Hereby enters this disclaimer to claims 2 and 11 in said specification.

[*Official Gazette, December 8, 1936.*]

May 15, 1934. W. A. DARRAH 1,958,406

ELECTRICAL SPRAYING DEVICE

Filed Dec. 27, 1929

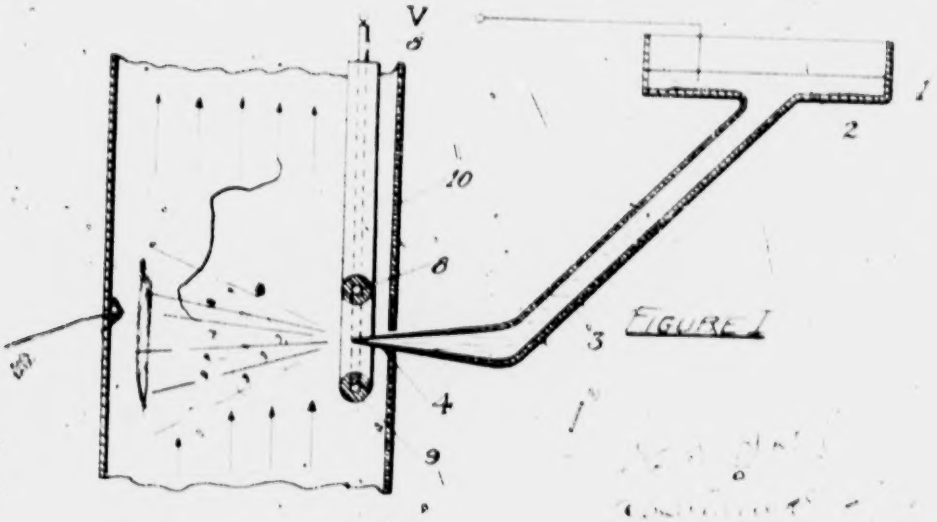

FIGURE I

FIGURE II

FIGURE III

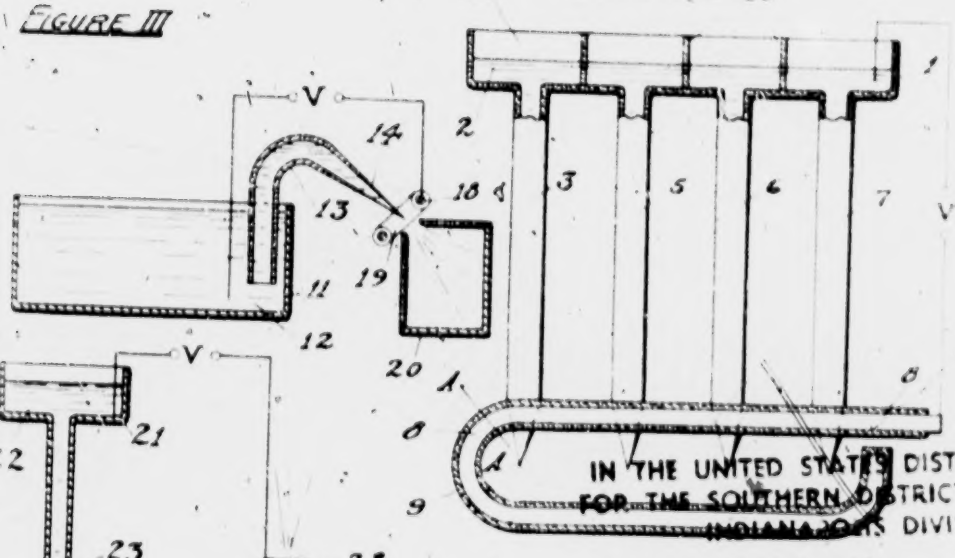

FIGURE IV

IN THE UNITED STATES DISTRICT COURT
FOR THE SOUTHERN DISTRICT OF INDIANA
INDIANAPOLIS DIVISION

BINKS MANUFACTURING CO.

V.

RANSBURG ELECTRO-COATING CORP.

Exh. No.

Richard A. Darrah.

INVENTOR

A current conducting rail 40 for making contact with the metal caps 29 of the supports 25, is insulatively mounted on the bottom of the chamber 10 by means of insulating blocks 41—41 and is connected to the negative terminal 43 of a source of uni-directional electrical energy produced by a mechanical rectifier 44 (Fig. 3) from a source of alternating current (not shown). The positive terminal 42 of the rectifier 44 is connected to the walls of the chamber 10 and also to a plurality of atomizing devices 45 suitably mounted alongside the chamber, as illustrated in Figs. 1 and 3.

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In practicing the invention, the shaft 17 is connected to and driven by any suitable source of power (not shown) so as to rotate the sprockets 15—15 keyed thereto and effect the movement of the sprocket chain 20 in the direction indicated by the arrows in Figs. 1 and 2. With the negative terminal 43 of the mechanical rectifier 44 connected to the current conducting rail 40 by a conductor 59, and the positive terminal 42 connected to the chamber 10 and the nozzle 50 by a conductor 60, the mechanical rectifier is operated to create a uni-directional current of high potential. The parts 26 to be coated are then placed on the hook portions 32—32 of the metal rods 30, and as the guards 35 engage and open the doors 11—11 in passing from compartment 12 into compartment 13 of the chamber 10, the metal caps 29 make contact with the current conducting rail 40. This contact connects the parts 26 to the negative terminal of the source of uni-directional electrical energy through laterally extending arms 31—31, metal rod and cap 30, 29, respectively, contact rail 40, and conductor 59 to the negative terminal 43 of the mechanical rectifier 44. As has been previously explained, the nozzle 50 of the atomizing device 45 is connected to a source of compressed air to effect the introduction of a coating material 52 in finely divided particles into the compartment 13. Since the atomizing device is connected to the positive terminal of the source of uni-directional electrical energy through nozzle 50, conductor 60 to the positive terminal 42 of the mechanical rectifier 44, the particles of coating material are given a positive charge as they emerge from the atomizing device 45 into the compartment 13 through apertures 55 in the chamber 10. The negatively charged parts 26 to be coated attract the positively charged particles of coating material so that the latter is deposited upon the surface of the parts 26 to form coatings thereon. A uniform coating of each part is assured, due to the fact that as the particles of the coating material are deposited thereon, the solvent of the coating material acts as a dielectric, whereby the positive charge is intensified at the uncoated spots on the parts 26 to better attract the particles of coating material thereto.

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7. A method of applying a finish to an article of manufacture consisting in enclosing a space of predetermined size, introducing into the enclosed atmosphere a coating material in a finely divided form, conveying the articles of manufacture to be coated through the enclosed atmosphere in spaced relation, and subjecting the articles of manufacture and the coating material to a difference of electrical potential to cause the coating material to be deposited on the articles of manufacture.

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9. In an apparatus for applying a finish to an article of manufacture, a chamber for enclosing the articles of manufacture to be coated, a conveyor for moving the articles of manufacture therethrough at predetermined intervals, means carried by the conveyor for electrically connecting the articles of manufacture to one terminal of a source of electrical energy at a predetermined time, an atomizing device for injecting particles of a coating material into the chamber, and means for connecting the atomizing device and the walls of the chamber to the opposite terminal of the source of electrical energy to repel the particles of coating material from the walls as they are attracted to and deposited upon the articles of manufacture.

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In witness whereof, I hereunto subscribe my name this 19th day of December, A. D. 1928.

EMERSON PUGH.

DISCLAIMER

1,855,869.—*Emerson Pugh*, Downers Grove, Ill. METHOD OF AND APPARATUS FOR COATING ARTICLES. Patent dated April 26, 1932. Disclaimer filed November 10, 1936, by the patentee; the assignee, *Western Electric Company, Inc.*, assenting and concurring.

Hereby enters this disclaimer to claims 2 and 11 in said specification.

[*Official Gazette December 8, 1936.*]

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May 15, 1934. W. A. DARRAH 1,958,406

ELECTRICAL SPRAYING DEVICE

Filed Dec. 27, 1926

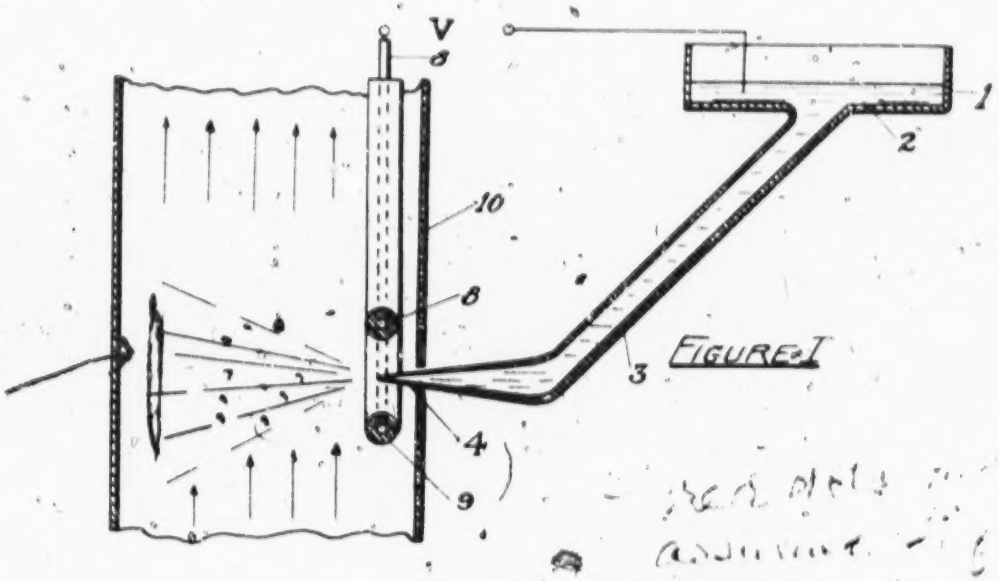


FIGURE I

FIGURE II

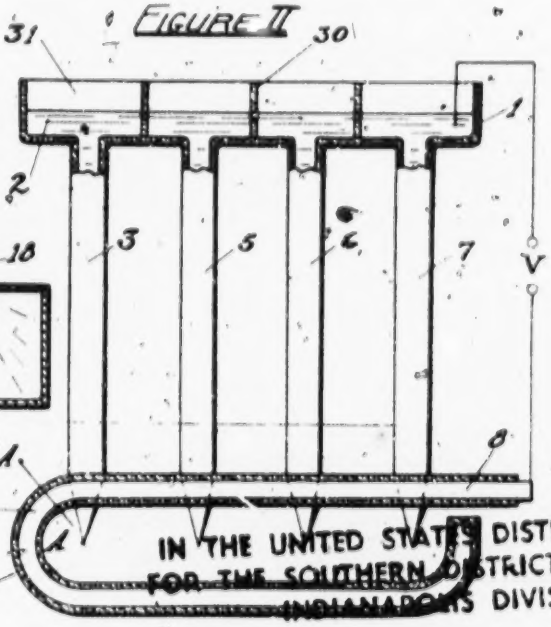
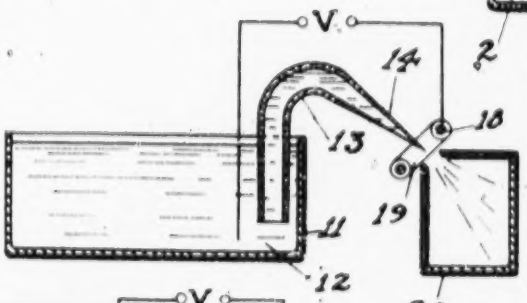


FIGURE III



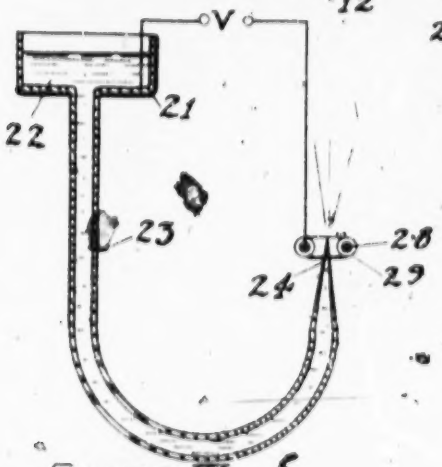


FIGURE IV

IN THE UNITED STATES DISTRICT COURT
FOR THE SOUTHERN DISTRICT OF INDIANA
INDIANAPOLIS DIVISION

BINKS MANUFACTURING CO.

V.

RANSBURG ELECTRO-COATING CORP.

CIVIL ACTION
NO. IP 56-C-262

Exh. No. _____

Richard W. Darrah

INVENTOR

Patented May 15, 1934

1,958,406

1083

UNITED STATES PATENT OFFICE

1,958,406

ELECTRICAL SPRAYING DEVICE

William A. Darrah, Chicago, Ill.

Application December 27, 1926, Serial No. 157,233

9 Claims. (Cl. 299—1)

This invention relates to electrical equipment which may be used for moving, spraying, atomizing or treating fluids and probably more nearly resembles an atomizer than any other type of common equipment, although it differs therefrom in many essential points.

One of the objects of this device is to produce a finely divided liquid spray by electrical forces and without the assistance of moving air streams or other means which are commonly employed for this purpose.

Another object of this invention is to provide a means for causing an action which may be either physical or chemical between gases and liquids.

Another object of this invention is to provide means for collecting or precipitating dust or suspended particles in gases.

Other objects will appear from the following description, claims and attached drawing.

The invention is exemplified in the combination and arrangement of parts shown in the accompanying drawing and described in the following specifications, and it is more particularly pointed out in the appended claims.

In the drawing:—

Fig. I shows a side elevation partly in section of one arrangement of this device;

Fig. II is a front elevation also partly in section showing a portion of the device illustrated in Fig. I;

Figure III shows a modified arrangement of this equipment;

Fig. IV shows a further modification.

Referring to the drawing, (1) represents a reservoir or container for liquid which is indicated by (2). The liquid may be either a conductor or an insulator as the results appear to be substantially the same. (3) represents a tube or pipe extending from reservoir (1) and may be of any desired material although I prefer an insulating substance. Tube (3) is drawn out into an extending point or nozzle (4) preferably relatively long and thin and with walls which are preferably thin. It is desirable to use insulating material for the nozzle (4).

A series of similar tubes (5), (6) and (7) are shown in Fig. II. Obviously as many tubes as are required may be employed. A conductor (8) is positioned near the end of nozzle (4) and may either be in the form of a circle or loop or a single straight or curved conductor as designed. Inasmuch as relatively high potentials are employed with this equipment I have found it convenient to insulate conductor (8) with a shell (9) although this feature is optional and depends upon the design of the equipment as well as its use. A source of potential which may be either direct current or alternating current is indicated by the letter "V" and is connected so that one terminal makes contact with conductor (8) and the other terminal with the fluid (2) in container (1). A duct or housing (10) is shown surrounding the end of nozzle (4) and the conductor (8). The object of duct or housing (10) is to confine the flow of gases or fluids which are subjected to the action of the spray produced by the equipment here described. The duct may be of either conducting or insulating material as desired. For the ordinary obvious reasons of electrical design it is desirable to have the portion of the duct (10) which is adjacent to the conductor, nozzle, etc., of insulating material.

Referring to Fig. III (11) indicates a container filled with fluid (12) into which tube or pipe (13) is placed. A nozzle (14) is formed at the end of pipe (13) and a conductor (18) is placed adjacent to the end of nozzle (14) as previously described. A source of potential "V" is connected as shown and a duct (20) is placed adjacent to the end of the nozzle (14) to confine the spray produced and direct the fluids which may come in contact with the spray. (19) indicates insulation applied around conductor (18).

Referring to Fig. IV (21) indicates a container holding fluid (22) and communicating to pipe (23) which is formed with a nozzle (24) at its end. A conductor (28) is shown adjacent the end of nozzle (24) surrounded with insulation (29) and connected to a source of potential "V" in the manner shown.

I have found that when equipment is assembled in substantially the manner indicated on the attached drawing, or with the obvious equivalent or modifications an exceedingly fine spray of drops of liquid or fluid particles are produced and many of the drops appear to carry a considerable electrical charge. The effect appears to be obtained with either direct current or alternating current. I have obtained results with potentials as low as one thousand volts applied between the conductor (8) and the liquid (2). I prefer to use much higher voltages preferably of 20,000 to 50,000 volts and the effects thus produced are very much more pronounced. The diameter of the nozzle at its tip may be varied over quite a large range, the effect being apparently merely to modify the size of the drops which are produced and, therefore, the quantity of fluid which passes through the nozzle. The quantity of fluid which passes through the nozzle is also very greatly increased by increasing the potential dif-

ference applied between the fluid in the nozzle and the conductor (8). I have also found that applying potential to only one of the two terminals will permit the production of the spray outlined above, but obviously with greatly reduced volume.

I have been able to spray such materials as water, various solutions of materials in water, alcohol, oils, dextrine and some low melting point alloys and metals.

I have found that the position of the conductor (8) with reference to the nozzle (4) is of considerable importance in effecting the volume, nature and direction of the discharge of the spray. In general I have secured best results when the conductor forms a loop around the terminal of nozzle (4) the loop being in a plane which is approximately perpendicular to the axis of the nozzle and located a small fraction of an inch back from the end of the nozzle. I do not wish to be confined to the location here described for the reason that the spray may be produced in large volume when the relative position of the conductor and nozzle have practically an infinite number of different locations from that described above. I have found that satisfactory results may be obtained with a single conductor as for example the portion of conductor (8) in Fig. II between the line A—A and its terminal.

It would appear that when the proper difference of potential is applied between the fluid in nozzle (4) and the conductor (8) that electrostatic forces cause the rapid throwing of small particles of liquid from the end of the nozzle. I have produced particles of liquid so small that they appear to remain suspended indefinitely in air at ordinary room conditions and so charged that they will oscillate in phase with variations in potential from a nearby electrical conductor. Such particles may be made to move so as to appear like ellipses or sine waves and appear to have an unusual resistance to evaporation partly due to the charge which they carry, and also the cooling effect.

Such particles I have found have the property of separating suspended materials floating in gases. For example smoke is almost instantaneously removed from gases by subjecting the smoke to the action of the spray produced by this equipment. Further the effect appears to be present whether alternating current or direct current is employed and for many commercial reasons I, therefore, prefer to use alternating current with this equipment.

I have noticed that more marked results are obtained when conductor (8) has a relatively small radius as for example similar to a fine wire. I have also noticed that better results appear to be obtained when the insulation (9) which surrounds conductor (8) is of only sufficient thickness to provide proper insulation. I have found that greater thickness of insulation around conductor (8) appears to distort the lines of electric force reducing the effect desired. In fact substituting a tube of insulating material substantially concentric with nozzle (4) of the insulating shell (9) around conductor (8), considerably reduces the spray effect.

On the other hand, the thickness of the wall of the nozzle (4) should be as small as possible. It would appear that thicker walls of nozzle (4) tend to distort the lines of electric force and distribute them over a considerable area instead of concentrating them near the end of nozzle (4).

I have found that the spray produced by this equipment is in good condition for rapid chemical action. For example oil sprayed with this equipment burns quite readily or if a spray of oil produced in this manner is directed into an atmosphere of reacting gas such as chlorine, the oil drops are quite completely chlorinated. Naturally effects of this kind can be controlled to some extent as far as degree and time is concerned by the temperature of the reacting materials, pressure and other obvious factors. Oil and chlorine are mentioned here merely as typifying the broad class of reactions which can readily be made to take place between liquids and gases with this equipment. Other examples of this location may be found in such materials as phenols and related compounds which may be oxidized, chlorinated or otherwise combined under conditions which will be obvious.

As a general illustration of the operation of this equipment it may be stated that smoke or other dust containing gases may be passed through duct (10) as for example in the direction of the arrows and subjected to the action of one or more spray devices of the type here described. Duct (10) may, of course, be vertical or horizontal and the flow of gases may be in any desired direction as best suits the specific case at hand.

The particles which compose the spray travel in approximately straight lines for a short distance after leaving the nozzle and then may be deflected or directed if desired by bringing conductors in close proximity to them. If left to themselves they frequently appear to take a parabolic course due apparently to the action of gravity. A slowly moving stream of gas or air, however, will readily carry the particles along with it and by placing conductors at desired points the moving particles may be directed in almost any desired direction.

It will be obvious from the description which has been given that this invention relates to a basic principle and a great many obvious modifications may be made in the specific arrangement of equipment or of portions, shape or size of the equipment, and still fall within the scope of this invention.

It will be obvious that I may equip container (1) as illustrated in Fig. II with one or more partitions as shown at (30) in which case I may have sprays carrying different materials from a multiple of nozzles and thus obtain a reaction between electrified sprays of different materials. Under these conditions electrical combination seems to take place with peculiar ease, and chemical reactions not readily obtained under normal conditions, may be obtained in this manner. If partition (30) is made of a conducting material no other electrical connection is necessary. If partition (30) is made of insulating material I may make individual contacts with each portion of container (1), thus causing two sprays of different materials to carry either like or unlike electrical charges as I prefer. Many obvious modifications of this arrangement will be apparent such as the use of two separate containers or the use of several sprays directed in any desired angle, for obtaining the most satisfactory admixture.

This equipment may be employed to obtain the oxidation of various materials, using a spray of the material to be oxidized introduced into an atmosphere of oxygen or gases containing oxygen. Considerable quantities of hydrogen peroxide may be produced by spraying water with this equipment into a current of air.

In a similar manner reducing reactions may

be carried out such as the addition of hydrogen to various compounds sprayed into it. Another example of the use of this equipment is the spraying of a solution of alkali such as hydroxide of soda into an atmosphere of carbonmonoxide when the usual addition products such as oxalates, etc., may be obtained.

When this equipment is used as a means of collecting or precipitating dust or suspended particles it will be apparent that the dust is collected on the electrified spray and may then be allowed to fall to the bottom of a collector or made to adhere to walls or other desired portions where it may be readily removed. It will be apparent that this method of removing suspended particles from gases is much more practical than the present methods.

When alternating current is applied to this device the size of the drops is smaller when the frequency is higher and vice versa.

Having now fully described my invention what I claim as new and wish to secure by Letters Patent in the United States, is as follows:

1. A device for spraying fluids consisting of a nozzle of insulating material, formed with a point at one end and a conductor spaced therefrom and extending transversely to said point, said conductor being entirely surrounded with an unbroken layer of insulating material, a source of liquid storage communicating with said nozzle and a device for creating a difference of electric potential between the fluid in said nozzle and said adjacent conductor.

2. A device for spraying fluids consisting of a pointed nozzle of insulating material and an electrically charged conductor entirely surrounded by an unbroken layer of insulation, said conductor being located adjacent the point of said nozzle and arranged to diffuse the discharge from said nozzle.

3. A device for spraying fluids consisting of a pointed nozzle connected to a source of liquid, a conductor completely surrounded with an unbroken layer of insulation, and arranged in a plane substantially perpendicular to said nozzle and adjacent thereto, and a device for creating an electric difference of potential between said conductor and the fluid of said nozzle.

4. In a device for spraying fluids a nozzle member of insulating material ending in a point, and a conductor completely surrounded by an unbroken layer of solid insulation located near the pointed end of said nozzle and arranged to diffuse the discharge from said nozzle.

5. In a spraying device an attenuated nozzle of insulating material, a conductor adjacent thereto and completely surrounded with an unbroken layer of solid insulation, and a device for creating an alternating electric field, between said conductor and said nozzle, said nozzle and said adjacent conductor being arranged to diffuse the discharge from said nozzle.

6. The combination of a fluid conducting nozzle of insulating material terminating in a point and an electric conductor distributed over a relatively large area, but spaced away from said point, and serving with said fluid in said nozzles as the terminals of a high tension electric field with the portions of said conductor forming the terminals of said field, completely surrounded with an unbroken layer of insulation.

7. A fluid conducting nozzle of insulating material having a fine discharge point with a single opening, a reservoir containing fluid connected to said nozzle and an electric conductor covering a large area and spaced away from said nozzles and forming with the fluid therein the terminals of an electric field, the portions of said electric conductor forming with said nozzles the terminals of an electric field being insulated from the fluid within said nozzle by means of an unbroken layer of solid insulating material, thereby preventing arcing discharge.

8. The combination of a liquid container, a fluid conducting nozzle of insulating material terminating in a point and connected to receive liquid from a container, an electric conductor spaced away from said nozzle and extending over a considerable area, thereby dispersing the discharge from said nozzle, said conductor serving with said fluid in said nozzle as the terminals of a high tension electric field, said electric conductor being completely surrounded with an unbroken layer of solid insulation to prevent arcing discharge between said conductor and said fluid in said nozzle, and a housing surrounding the point of said nozzle.

9. The combination of a liquid container, a fluid conducting nozzle of insulating material terminating in a point and connected to receive liquid from said container, an electric conductor spaced away from said nozzle and extending over a considerable area, thereby dispersing the discharge from said nozzle, said conductor serving with said fluid in said nozzle as the terminals of a high tension electric field, said electric conductor being completely surrounded with an unbroken layer of solid insulation to prevent arcing discharge between said conductor and said fluid in said nozzle, a housing adjacent the point of said nozzle and arranged to receive the fluid passing therefrom.

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Nov. 12, 1940. H. A. WINTERMUTE 2,221,338

DEPOSITION OF MATERIAL

Filed Oct. 21, 1936 2 Sheets-Sheet 1

Fig. 1.

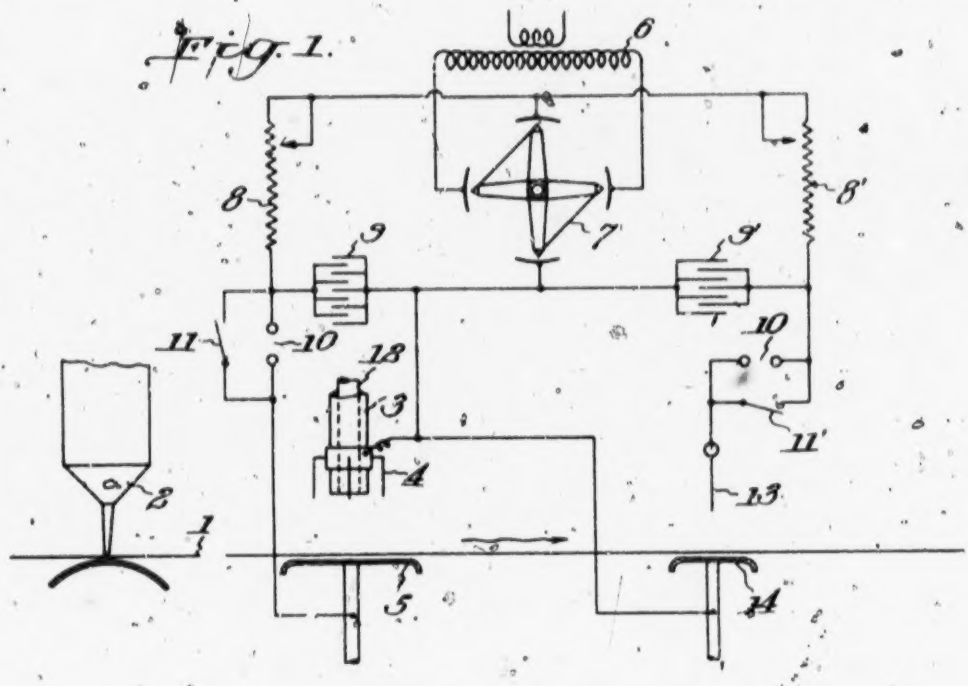
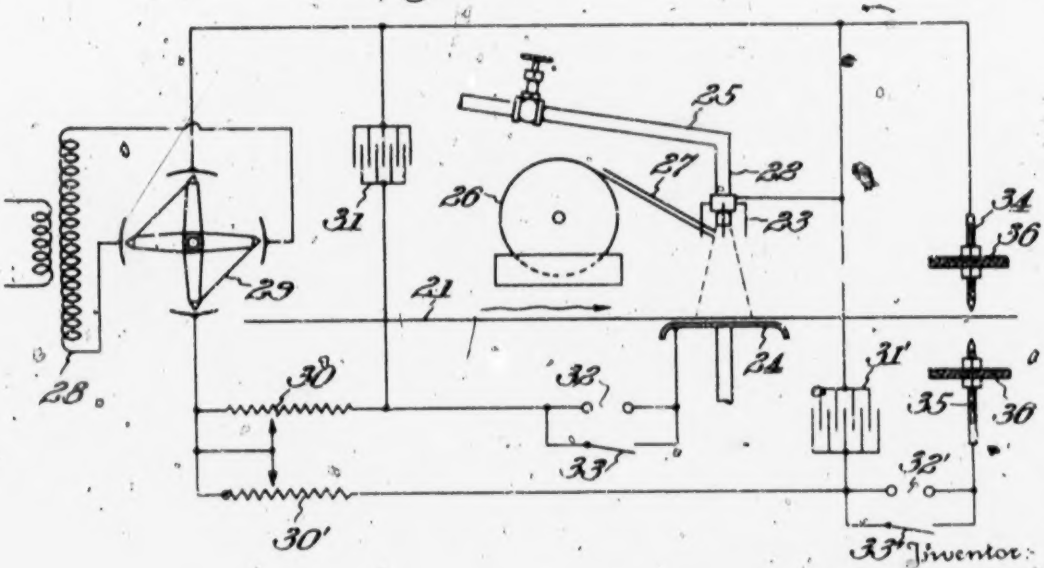


Fig. 2.



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Nov. 12, 1940. H. A. WINTERMUTE 2,221,338

DEPOSITION OF MATERIAL

Filed Oct. 21, 1936 2 Sheets-Sheet 2

Fig. 3.

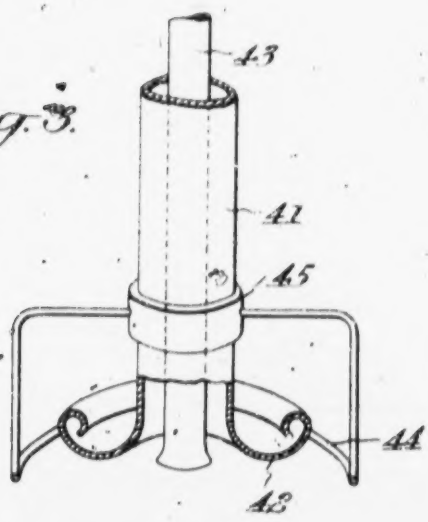
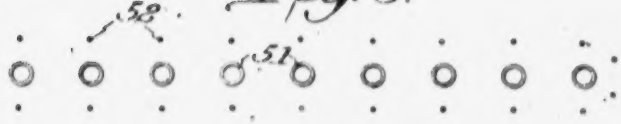


Fig. 4.

Fig. 5.



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Patented Nov. 12, 1940

2,221,338

UNITED STATES PATENT OFFICE

2,221,338

DEPOSITION OF MATERIAL

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Application October 21, 1936, Serial No. 106,863

21 Claims. (Cl. 91—8)

This invention relates to the deposition of materials, particularly for the formation of coatings by depositing finely divided materials on surfaces. The invention comprises novel methods and apparatus for effecting the deposition of a wide variety of materials, and is particularly adapted to the deposition of materials which are supplied to a surface to be coated dispersed in or associated with a current of air or other gas.

A principal purpose of the invention is the provision of methods and apparatus for the efficient and economical deposition of materials.

A further purpose of the invention is to provide methods and means whereby the loss of materials and unhealthful atmospheric conditions attendant on the deposition of finely divided materials may be avoided.

Another purpose of the invention is the provision of methods and means for the removal of static charges from coated materials, particularly in conjunction with coating process utilizing electrical methods of deposition or an electrical method of treating the coating material before, during or after deposition.

The invention is not limited to the deposition or coating of any particular type of material, but it is of special value in the deposition of poorly conducting materials to form coatings or impregnations upon a base material. It may be utilized for example, in the deposition of fibrous particles upon an adhesive covered base to form a simulated pile surface, or it may be used in connection with the deposition of finely divided particles of wax on the surface of freshly printed paper or the like to prevent offsetting of the printed matter on adjacent sheets.

The invention includes the use of corona discharges to aid in the deposition of the materials and to prevent the escape of the materials into the surrounding atmosphere. This is effected by providing a curtain of corona discharge around the area within which the material being deposited is to be confined. In this manner the particles are given an electric charge which is utilized in confining the particles to the desired area and preventing the loss into the surrounding atmosphere. This is particularly desired in operations where the materials are borne to the area of deposition in a current of carrier gas, such as air, as the air flowing away from the area tends to carry away relatively large amounts of the material. This may be wholly or largely prevented by means of the invention.

In this and other methods of depositing involving the use of electrical charges the base upon which the materials are deposited tends to accumulate an electrical charge which is usually disadvantageous in the subsequent handling and treatment of the material and may cause a definite hazard. The invention includes the use of corona discharges to remove such accumulated charges, thereby eliminating hazards and difficulties in handling the material.

The provision of a curtain of discharge about an area to be coated, for example, may advantageously be effected by providing attenuated discharge elements about the member supplying the gaseous current utilized to carry the coating material. These discharge elements, which may consist for example, of a plurality of points or of one or more wires or edged members, are so positioned with respect to an electrode member of extended surface that upon impressing a high potential voltage across the space between the discharge elements and the extended electrode member a curtain of corona discharge emanates from the discharge elements in the direction of the extended electrode. By suitably positioning the elements the curtain of corona can be caused to substantially surround or "fence off" any desired area. It is desirable to impress a unidirectional potential between the electrodes and particularly advantageous results are obtained by the use of a pulsating current characterized by a series of unidirectional impulses of steep wave front. This type of current supply has the advantages over alternating or oscillating impulses and over ordinary unidirectional pulsating current having sine wave characteristics, that it permits the use of higher voltages without causing arc-over, often to the extent of 150% to 200%. The corona discharges produced by this type of current supply have a much greater ionizing effect on the air or other gas, thereby increasing the effectiveness of the curtain. A further advantage of this type of current is that the corona discharge is formed in a substantially continuous line along the wire or discharge edge instead of in spaced tufts of discharge such as are produced by ordinary forms of current supply.

For the same reasons the steep wave front impulses have been found to be particularly advantageous for the energization of the charge eliminating means.

For the purpose of illustrating the invention it will be further described with reference to the accompanying drawings in which:

Fig. 1 is a diagrammatic showing of apparatus embodying the principles of the invention;

Fig. 2 is a diagrammatic showing of a modified embodiment of the invention;

Fig. 3 is a detail fragmentary view in partial section of a supply nozzle constructed in accordance with the principles of the invention; and

Figs. 4 and 5 are plan views of modified forms of supply members constructed in accordance with the principles of the invention.

The apparatus illustrated in Fig. 1, is adapted, for example, to the production of pile surfaced materials by the deposition of fibrous particles, such as rayon flock, on a suitable base, and its operation will be described with reference to the production of such materials.

A base material 1, for example, a web of textile fabric or of paper, is passed, preferably in continuous manner, through the apparatus in the direction of the arrow. An adhesive is supplied to the upper surface of the base by means of coating device 2. The adhesive is not necessary when depositing particles which have adhesive qualities.

The base material then passed through an electric field established between electrodes 3, 4 forming a supply nozzle, and opposing plate electrode 5. The electrodes are energized by means of a circuit including transformer 6, rectifier 7, resistance 8, condenser 9, and spark gap 10. This circuit provides impulses of steep wave front. By closing switch 11 ordinary high voltage unidirectional pulsating current is provided.

Finely divided material, such as rayon flock, is supplied through duct 12 of the nozzle 3 by means of a carrier current of air. The material enters the zone of deposition between the opposing electrodes and is deposited on base 1 both by impact and by electrical deposition. The attenuated electrode members 4 provide a curtain of corona discharge surrounding the zone of deposition which effectively prevents the current of air from carrying undeposited material out of the zone of deposition.

The electrical charge carried by the deposited particles to the base material is removed by passing the base through a further electric field wherein the material is subjected to the action of a corona discharge of opposite polarity to the first field. The second field is established between attenuated electrode 13 and opposed plate electrode 14, although electrodes of other forms such as opposed point or edge electrodes may be used. The electrodes are energized with sharp wave front impulses by means of a circuit including transformer 6, rectifier 7, resistance 8', condenser 9' and spark gap 10'. The spark gap may be eliminated from the circuit by closing switch 11' thereby providing ordinary rectified high potential current.

In the form of apparatus shown in Fig. 2, which is particularly suitable for depositing self-adhesive materials such as wax, the web of base material 21 is passed through the apparatus in the direction of the arrow, first passing through an electrical field established between nozzle 22 carrying attenuated electrodes 23 and opposing plate electrode 24. A stream of air, preferably heated, is supplied to the nozzle through duct 25, and wax is fed to the stream of air by means of feeding drum 26 and feed trough 27.

Unidirectional high potential impulses of sharp wave front are supplied to the electrodes by means of a circuit including transformer 28, rectifier 29, resistance 30, condenser 31 and spark gap 32. The spark gap may be eliminated from the circuit by closing switch 33.

The wax particles are caused to deposit on the web and are prevented from leaving the zone of deposition with the current of air passing off laterally by means of the curtain of corona discharge set up between attenuated electrodes 23 and plate electrode 24.

The accumulated charge on the web is removed by subjecting it to corona discharge of opposite polarity between electrodes 34 and 35, which are adjustably mounted in insulating supports 36. The supply circuit includes transformer 28, rectifier 29, resistance 30', condenser 31' spark gap 32' and switch 33'.

In the apparatus of Figs. 1 and 2, the current supply to both the deposition zone electrodes and the charge removing electrodes can be supplied from a single condenser-spark gap set but flexibility of operation is gained by the arrangement illustrated.

Fig. 3 shows in detail a feeding nozzle which is particularly suitable for the deposition of fibrous materials, such as flock fibers. The lower end 42 of the nozzle 41 is expanded and rounded back so as to avoid the formation of corona discharge immediately adjacent the flock fibers which are fed through supply duct 43. The curtain of corona discharge is formed from attenuated wire discharge electrode 44 which is suspended from the nozzle by means of adjustable collar 45.

Figs. 4 and 5 show nozzle arrangements provided with a plurality of nozzles which may be positioned in the apparatus, for example, so as to extend across a wide web of base material.

In Fig. 4 nozzles 48 are surrounded by edge discharge elements 49 which may be formed of wire or of strips of metal.

In Fig. 5 nozzles 51 are surrounded by point discharge elements 52.

In both cases the discharge elements form a curtain of corona discharge which fences in the material issuing from the nozzle and effectively prevents it from being carried away from the zone of deposition.

I claim:

1. In the deposition of particles of material upon a base by means of a carrier gas stream, the improvement which comprises surrounding the zone of deposition with corona discharge.

2. In the deposition of particles of material upon a base by means of a carrier gas stream, the improvement which comprises surrounding the zone of deposition with corona discharge generated by high potential impulses of steep wave front.

3. In the deposition of particles of material upon a base by means of a carrier gas stream, the improvement which comprises surrounding the zone of deposition with corona discharge and thereafter removing accumulated electrical charges from the material by subjecting it to the action of a second corona discharge of opposite polarity.

4. A method of depositing material on a base which comprises dispersing the material in a stream of gas, bringing the material to the base in said stream of gas, surrounding the stream of gas at the zone of deposition with a curtain of corona discharge and thereafter removing accumulated electrical charges from the material by subjecting it to the action of a second corona discharge of opposite polarity.

5. A method of depositing material on a base

which comprises passing the base through a high potential electric field, bringing the material to be deposited into said field and surrounding the zone of deposition with a curtain of corona discharge.

6. A method of depositing material on a base which comprises passing the base through a high potential electric field, bringing the material to be deposited into said field, and surrounding the zone of deposition with a curtain of corona discharge generated by high potential impulses of steep wave front.

7. A method of depositing material on a base which comprises passing the base through a high potential electric field, bringing the material to be deposited into said field, surrounding the zone of deposition with a curtain of corona discharge and thereafter removing accumulated eletcrical charges from the material by subjecting it to the action of a second corona discharge of opposite polarity.

8. A method of removing electrical charges from a web of material which comprises subjecting it to the action of a corona discharge generated by unidirectional high potential impulses of steep wave front.

9. Apparatus for depositing particles of material upon a surface comprising a conduit for supplying the material adjacent the surface, attenuated electrodes positioned adjacent the mouth of said conduit, an extended surface electrode opposed to said attenuated electrodes, and means for impressing high potential across said electrodes sufficient to produce corona discharge from said attenuated electrodes.

10. Apparatus for depositing particles of material upon a surface comprising a conduit for supplying the material adjacent the surface, attenuated electrodes positioned adjacent the mouth of said conduit, an extended surface electrode opposed to said attenuated electrodes, and means for impressing pulsating high potential across said electrodes sufficient to produce corona discharge from said attenuated electrodes.

11. Apparatus for depositing particles of material upon a surface comprising a conduit for supplying the material adjacent the surface, attenuated electrodes positioned adjacent the mouth of said conduit, an extended surface electrode opposed to said attenuated electrodes, and an electrical circuit including a source of high potential alternating current, a rectifying device, a capacitance, and a spark gap for impressing pulsating high potential impulses of steep wave front across said electrodes sufficient to produce corona discharge from said attenuated electrodes.

12. Apparatus for depositing particles of material upon a surface comprising a conduit for supplying the material adjacent the surface, attenuated electrodes surrounding the mouth of said conduit, an extended surface electrode opposed to said attenuated electrodes, and means for impressing high potential across said electrodes sufficient to produce corona discharge from said attenuated electrodes.

13. Apparatus for depositing finely divided material on a web comprising attenuated electrodes, an extended surface electrode spaced therefrom, means for passing the web between said electrodes adjacent the extended surface electrode, means for impressing a high potential across said electrodes to establish a curtain of corona discharge extending toward said extended surface electrode and means for supplying a stream of gas carrying finely divided material within said curtain of corona discharge.

14. Apparatus for depositing finely divided material on a web comprising attenuated electrodes, an extended surface electrode spaced therefrom, means for passing the web between said electrodes adjacent the extended surface electrode, means for impressing high potential impulses of steep wave front across said electrodes to establish a curtain of corona discharge extending toward said extended surface electrode and means for supplying a stream of gas carrying finely divided material within said curtain of corona discharge.

15. Apparatus for depositing finely divided material on a web comprising attenuated electrodes, an extended surface electrode spaced therefrom, means for passing the web between said electrodes adjacent the extended surface electrode, means for impressing a high potential across said electrodes to establish a curtain of corona discharge extending toward said extended surface electrode and defining an area of deposition on said web, and means for supplying a stream of gas carrying finely divided material within said curtain of corona discharge.

16. Apparatus for depositing finely divided material on a web comprising attenuated electrodes, an extended surface electrode spaced therefrom, means for passing the web between said electrodes adjacent the extended surface electrode, means for impressing a high potential across said electrodes to establish a curtain of corona discharge extending toward said extended surface electrode, means for supplying a stream of gas carrying finely divided material within said curtain of corona dscharge and means for subjecting said web to a further corona discharge of opposite polarity.

17. Apparatus for depositing finely divided material on a web comprising attenuated electrodes, an extended surface electrode spaced therefrom, means for passing the web between said electrodes adjacent the extended surface electrode, means for impressing a high potential across said electrodes to establish a curtain of corona discharge extending toward said extended surface electrode, means for supplying a stream of gas carrying finely divided material within said curtain of corona discharge and means for removing electrical charges from said web comprising opposed electrodes at least one of which is shaped to emit corona discharge and means for supplying a high potential to said electrodes.

18. Apparatus for removing electric charges from a web of material which comprises opposed electrodes at least one of said electrodes being of attenuated shape, a source of high potential alternating current, circuit elements connecting said source with said electrodes including a rectifying device, a capacitance, and a spark gap for impressing unidirectional high potential impulses of steep wave front across said electrodes sufficient to produce corona discharge from said attenuated electrodes, and means for passing the web between said electrodes.

19. A method of removing electrical charges from a web of material which comprises subjecting it to the action of a substantially continuous line of corona discharge generated by unidirectional high potential impulses of steep wave front.

20. A method of forming a pile surface on a base material which comprises coating a surface of the base with an adhesive, passing the ad-

heavily coated base through a high potential electric field, bringing fibrous material into said field and depositing said fibrous material on the adhesively coated base while surrounding the zone of deposition with a curtain of corona discharge.

21. A method of forming a pile surface on an adhesively coated base material which comprises coating a surface of the base with an adhesive, establishing a high potential electrical field between an electrode and the adhesively coated base, bringing fibrous material into said field and depositing such fibrous material on the adhesively coated base while surrounding the zone of deposition with a curtain of corona discharge.

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July 1, 1941. H. P. RANSBURG ET AL 2,247,963

APPARATUS FOR SPRAY COATING ARTICLES

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FIG. 1

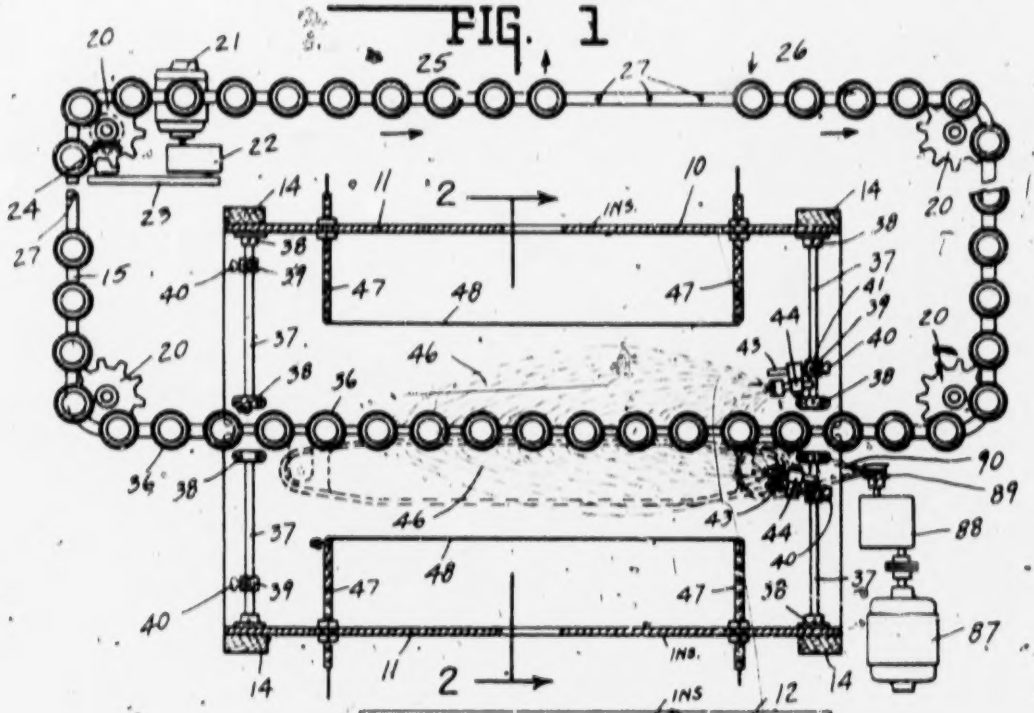
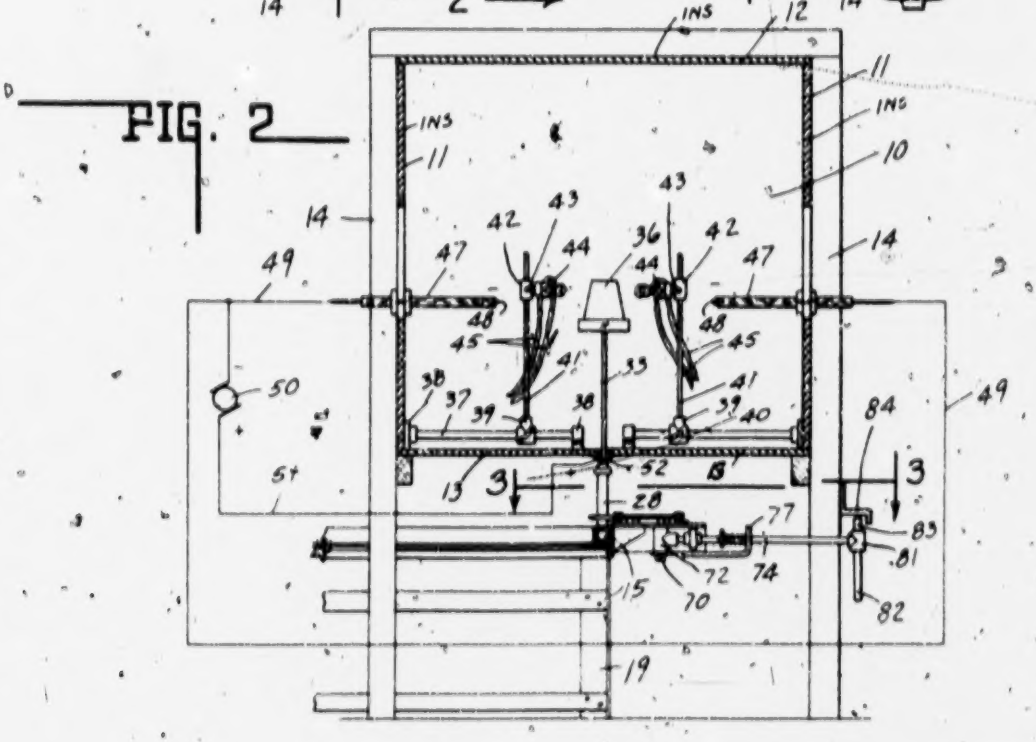


FIG. 2



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APPARATUS FOR SPRAY COATING ARTICLES

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FIG. 3

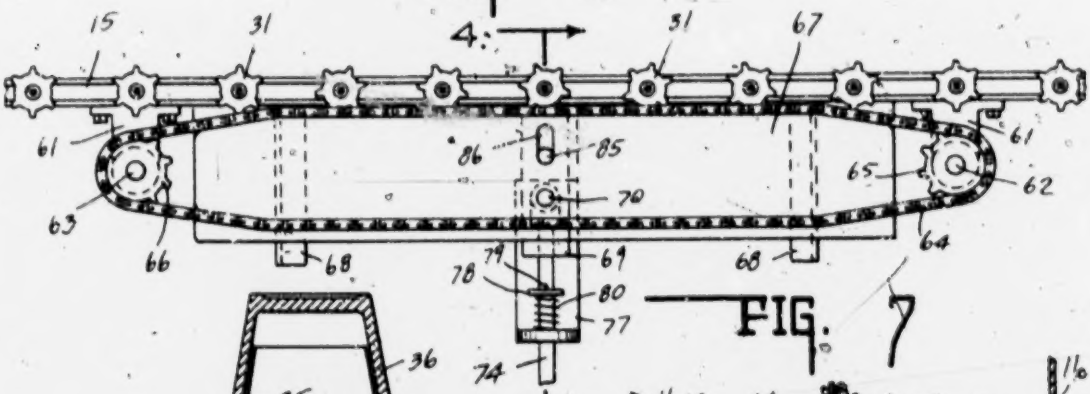
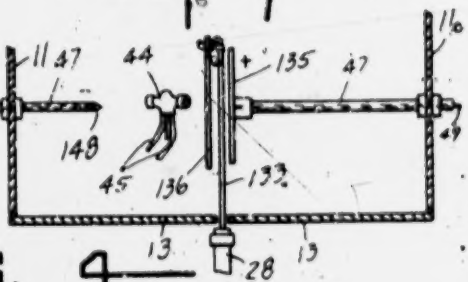


FIG. 7



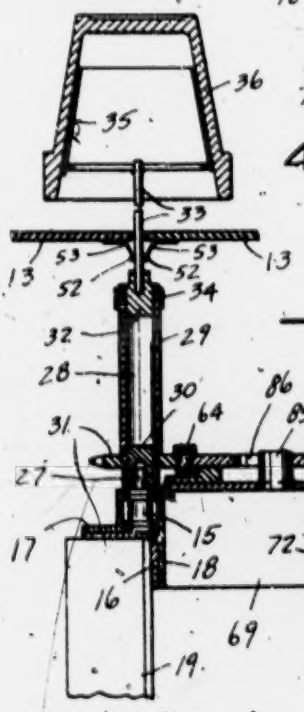


FIG. 4

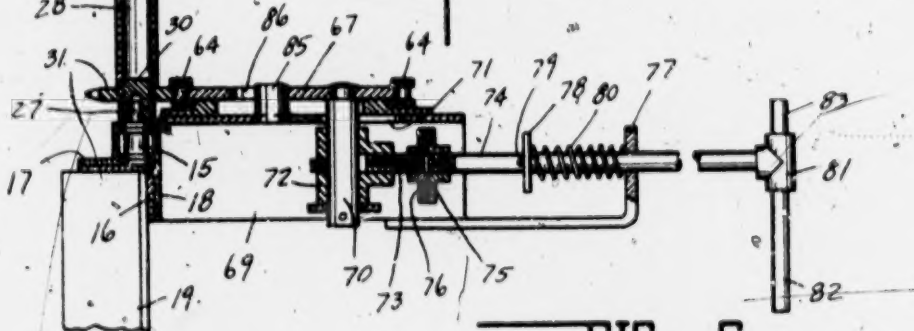


FIG. 5

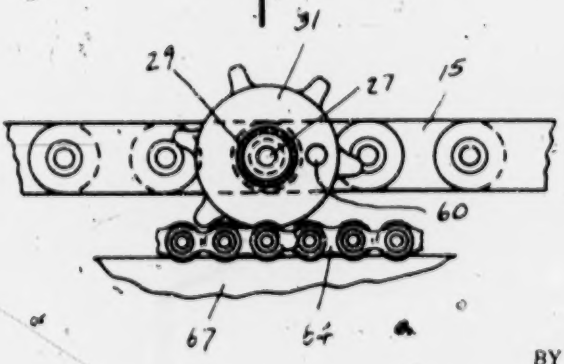
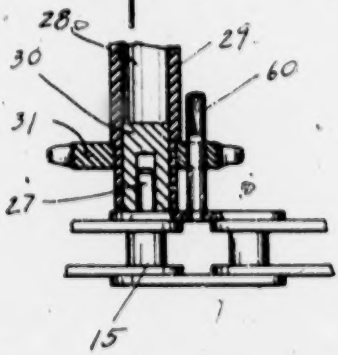


FIG. 6



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2,247,963

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UNITED STATES PATENT OFFICE

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APPARATUS FOR SPRAY COATING ARTICLES

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Application June 29, 1939, Serial No. 281,766

5 Claims. (Cl. 91—45)

This invention relates to apparatus for spray coating articles in which the deposition of coating material is accomplished wholly or in part by electrostatic means. Certain features of the apparatus disclosed herein are disclosed and claimed in co-pending application of Harry J. Green, Serial No. 213,945, filed June 15, 1938, and methods of coating articles in which the present apparatus may be used are claimed in application Serial No. 308,024, divided from the present application and filed December 2, 1939.

In apparatus of this general type it has heretofore been the practice to provide a collecting electrode and a discharge electrode between which an electrostatic field is set up. Usually the article to be coated is the collecting electrode and the discharge electrode is in the form of a spray gun or other device used to direct a spray of coating material into the electrostatic field. In some cases the discharge electrode has been an object placed near the spray gun or in the path of the spray from the gun rather than the gun itself. The whole has been enclosed in a metal cabinet maintained at the potential of the discharge electrode. The theory of operation of such apparatus has been that the spray particles in touching or passing near a positively charged discharge electrode, for example, pick up initial positive charges which cause them to be attracted to the negatively charged collecting electrode and to be repelled from the positively charged walls of the cabinet.

We have found, however, that spray particles do not behave in the manner to be expected from the application of this theory. Even though the gun itself is the discharge electrode and all particles of the spray may then be expected to be electrically charged, still the spray particles apparently move toward a positively charged electrode as readily as toward a negative one, other things being equal. The walls of the cabinet, even when charged at the same potential as the gun, have substantially the same attractive effect as when charged at the opposite potential. In cases where the discharge electrode is placed in the path of the spray said electrode apparently acts as a collector of spray particles.

One object of the present invention is generally to increase the efficiency of spray coating methods and apparatus of the type described and particularly to reduce the amount of coating material lost by deposition on the walls of the cabinet and on the discharge electrode. This object is attained in part, first, by substituting a cabinet formed completely of insulating material for the metallic cabinet heretofore used; second, by placing the discharge electrode as completely as possible out of the path of the spray from the gun; and third, by suitably proportioning the sizes of the discharge and collecting electrodes.

The substitution of an insulated cabinet for a metallic one in any given installation materially reduces the amount of spray material collected thereon. In some installations the deposition of spray material on the cabinet has been practically eliminated whereas with a metal cabinet a heavy coating of such material quickly appeared on the cabinet. Apparently only such particles as receive an initial velocity and direction from the gun such that they cannot be deflected by the electrostatic attraction of the electrodes can reach the walls of the insulated cabinet, whereas, with a metal cabinet, a large number of such particles are actually attracted to the cabinet irrespective of the potential at which the cabinet is maintained.

The behavior of the particles indicates that it is unnecessary to give them an initial charge by contact or proximity to an electrode charged in the opposite potential to the collecting electrode. Apparently particles discharged into an electrostatic field are attracted to either electrode. Other things being equal, the attractive effect of a positively charged electrode is considerably greater than that of a negatively charged electrode but the attractive effect of any electrode increases immensely with an increase in the size of electrode. These facts have made it possible to increase the efficiency of the apparatus by placing the discharge electrode out of the path of spray particles and by making the discharge electrode relatively small and the collecting electrode relatively large. For the coating of small objects the discharge electrode may be in the form of a point, while for a succession of articles moving on a conveyor the discharge electrode is preferably in the form of a fine wire or a series of points arranged parallel to the direction of travel.

Another object of the invention is to provide efficient means for coating articles having a surface area too small to comprise an efficient collecting electrode. This object is attained by grouping a plurality of such articles in such way as to cause all members of the group to be presented simultaneously to the discharge electrode in such manner that their aggregate area is much greater than that of the discharge electrode.

Another object of the invention is to coordinate the velocity and direction of the spray with

the strength of the electric field and the position of the article to be coated in such manner that as little as possible of the spray fails to reach the articles. In the ordinary spray gun used for paint spraying, particles of varying sizes are created and these particles lose their initial velocities at various distances from the gun, depending upon their size. In prior practice in the painting of small articles particularly, many of the larger particles reach the region of the article to be coated with such a high velocity remaining that they cannot be pulled in by electrostatic attraction and are carried past the article. Small particles, on the other hand, lose their velocities before they can approach close enough to the articles to be attracted electrostatically. In the present invention, in one of its preferred forms, a series of articles to be coated is moved in a predetermined path adjacent to the spray gun. The gun is directed roughly parallel to the path or inclined at an acute angle to the path so that the articles successively pass close to the points at which the initial velocities of the particles of varying sizes are lost. Thus the particles of all sizes find themselves in the region of one of the articles at the time that their initial velocities have been sufficiently reduced to permit the same to be electrostatically attracted to the article. By this means a large percentage of the paint ordinarily lost because of the varying size and velocity of the spray particles actually reaches the articles.

Another object of the invention is to minimize the hazard of explosion in electrostatic spray painting with materials having inflammable solvents.

Another object of the invention is to provide an efficient method and apparatus for electrostatic spray painting of articles formed of non-conducting materials.

Other objects and features of the invention will be understood from the accompanying drawings and the following description and claims:

Fig. 1 is a plan view of a spray painting apparatus constructed in accordance with a preferred form of the invention and having the cabinet shown in section. Fig. 2 is a vertical sectional view taken on the line 2—2 of Fig. 1. Fig. 3 is a plan view of conveyor apparatus used with the invention and is taken substantially on the line 3—3 of Fig. 2. Fig. 4 is an elevational sectional view taken on the line 4—4 of Fig. 3. Fig. 5 is a plan view of a detail of the apparatus of Figs. 3 and 4. Fig. 6 is an elevational view of the same partly in section. Fig. 7 is an end elevational view showing an adaptation of the invention to the coating of a different type of object.

In the preferred form of the invention shown in the drawings there is provided a cabinet 10 consisting of side walls 11, top 12 and floor plates 13, all supported by vertical posts 14. The cabinet, including the vertical posts 14, is preferably constructed entirely of electrically non-conducting materials such as wood or Bakelite or other suitable plastics. Attention is called particularly to the use of non-conducting material for the supporting posts 14. Even though an insulated cabinet is used, if the supporting posts are of metal, an appreciable deposit of coating material is found on the inner wall of the cabinet in the region of the supporting posts. As will be apparent from the drawings, the cabinet is completely open to the atmosphere at both ends. It has been found that when the combined areas of the open ends of the cabinet measured in square feet is at least equal to one-third of the total volume of the cabinet measured in cubic feet, there is no danger of explosion with electrostatic deposition of paints or enamels using ordinary commercial solvents. If the area of the open ends is less than this figure, the interior of the cabinet approaches too closely to a confined space in which an explosive mixture may be accumulated. In the cabinet illustrated in the drawings, the ratio of end area to volume is approximately one square foot to three cubic feet.

Beneath the floor of the cabinet there is provided a conveyor chain 15 supported on a trackway formed by an angle iron 16, an angle iron 17 and a plate 18 (Fig. 4). Said trackway is suitably supported by legs 19. The conveyor chain is trained about sprockets 20 and may be continuously driven by a motor 21 operating one of said sprockets through a reduction gear unit 22, a belt drive 23 and beveled gears 24. The path of the conveyor chain is best seen in Fig. 1 and leads from beneath the cabinet past an unloading station 25 and a loading station 26 and then again beneath the cabinet. At suitable intervals along the conveyor chain there are provided upwardly extending pins 27 each adapted to enter a mating opening in the lower end of a carrier unit 28. Each of said carrier units, as best seen in Fig. 4, includes a sleeve 29 preferably formed of insulating material and having in its lower end a plug 30 provided with an opening to receive the pin 27. A sprocket 31 is mounted near the lower end of the sleeve 29. A plug 32 is secured in the upper end of the sleeve 29 and is provided with a recess adapted to receive an upwardly extending rod 33. A collar 34 tightly secured about the upper end of the sleeve 29 prevents undesired displacement of the plug 32. The rod 33 extends upwardly through an opening between the two bottom plates 13 of the cabinet and carries at its upper end an electrical terminal in the form of an electrode 35 herein shown as of frusto-conical shape formed of sheet metal and serving as a support for an article 36 to be coated. In the example shown herein the article is in the form of a flowerpot and may be of non-conducting material, such as ceramic ware.

At each end of the cabinet close to the floor there are mounted a pair of rods 37 suitably supported in fittings 38 and each having mounted thereon one or more slidable fittings 39. Said fittings 39 may be secured at any desired place along the rods 37 by means of thumb screws 40 and each of said fittings is adapted to receive a vertical rod 41. Fittings 42 are carried by the vertical rods 41 and are similar to the fittings 39. Said fittings 42 carry horizontal rods 43 adapted to support spray guns 44. Said spray guns may be of a well known commercial form and are connected by tubing 45 to a suitable source of a coating material such as paint, lacquer or enamel and a source of compressed air for atomization. By means of this construction the spray guns may be positioned as desired adjacent either end of the cabinet. In the arrangement shown in the drawings two such guns are used at one end of the cabinet and are located to direct a spray 46 of coating material in the general direction of the opposite end of the cabinet. One of said guns is positioned on each side of the path of movement of the articles 36 through the cabinet. Preferably all or a part of the sup-

porting structure for the guns is formed of insulating material and the tubing 45 is also of non-conducting material. The guns are, therefore, isolated from the electrical apparatus and do not impart any electrical charge to the spray particles nor tend to attract stray particles of the coating material.

On each of the side walls 11 of the cabinet there is mounted a pair of tubular insulating members 47 extending inwardly toward the path of travel of the articles 36. An electrode 48 in the form of a fine wire is strung between the inner ends of each of the insulators 47 and extends generally parallel to the path of travel of the articles. Each of said electrodes extends outwardly through one or both of the insulators 47 and is connected by a conductor 49 to one terminal of an electrical generating apparatus 50 shown diagrammatically in Fig. 2. The opposite terminal of said apparatus is connected by a conductor 51 to a pair of wires 52 (Fig. 4), which extend longitudinally beneath the floor of the cabinet and are supported on spring clips 53 carried by the cabinet floor. The wires 52 are adapted to engage the vertical rods 38 in their travel through the cabinet and thus serve to make an electrical connection between the generating apparatus 50 and each of the electrodes 35. Preferably the generating apparatus is adapted to supply direct current with a voltage of the order of 100,000 volts. The discharge electrodes 48 are preferably connected to the negative terminal and the collecting electrodes 35 to the positive terminal. By this means an electrostatic field of high intensity is set up between the discharge electrodes 48 and the collecting electrodes 35. Since the discharge electrodes 48 have an extremely small surface area as compared to the total surface area of the collecting electrodes 35 presented thereto, the last named electrodes exert a much more powerful attractive effect on the spray particles than do the electrodes 48. The tendency of the discharge electrodes 48 to collect spray particles is further diminished by the fact that they are located at the extreme edge of the normal path of the spray from the guns 44 or completely out of said path.

By means of the arrangement of the spray guns just described, the path of the spray and the path of the articles 36 is such that both small and large spray particles lose their initial velocities at points adjacent to the path of travel of the article. Thus there is always an electrically charged article reasonably close to exert an attractive effect on each slowly moving particle. The efficiency of the paint collection is, therefore, immensely increased over that of any arrangement in which the spray is directed substantially at right angles to the path of travel of the articles. The velocity of spray is normally adjusted so that none of the spray particles pass beyond the confines of the cabinet. It is immaterial in which end of the cabinet the spray guns are mounted. In fact, one may be mounted in one end and the other in the opposite end. Such an arrangement is beneficial in certain installations. Where only one side of each article is to be coated only one gun and one discharge electrode may be required. In other cases, such as for larger objects, more than one gun may be required on each side of the conveyor.

It is to be noted particularly that the articles to be coated need not be electrical conductors. When said articles are so placed as to mask the collecting electrode so that the electrostatic field must pass through the article, the efficiency of the collecting electrode is not materially impaired. Paint which is attracted by the collecting electrode is then deposited on the outer surface of the article. It is not necessary in all cases that the collecting electrodes be carried by the conveyor and act as supports for the articles. Where only one side of an article is to be coated it may be advantageous in some cases to mount a collecting electrode in a stationary position on the side of the conveyor opposite to the discharge electrode. Such an arrangement is illustrated in Fig. 7 in which an object 136 to be coated on one side only is in the form of a thin plate of non-conducting material. Said object is carried by a support 133 which may be mounted in the carrier 28 in the same manner as the rod 38 previously shown. The discharge electrode may be in the form of a metallic point 148 mounted on the end of one of the insulators 47. The collecting electrode is shown as a plate 135 carried on a similar support on the opposite side of the path of travel of the article 136. The spray gun 44 discharges the paint spray into the space between the discharge electrode and the object. In apparatus of this kind it is advantageous to move the conveyor intermittently, stopping each of the objects 136 between the electrodes for a sufficient length of time to receive a thorough coating of paint. In the claims the phrase "a terminal associated with said article" is intended to include an electrode such as those specifically illustrated for use with non-conducting articles or an electrically conducting element to which a conducting article which is itself the collecting electrode may be connected. Thus the member 35 of Fig. 4 may or may not serve as the collecting electrode, depending upon whether non-conducting or conducting articles are to be coated, but in either case it is a "terminal associated with the article."

For objects not placed too closely together on the conveyor, the electrical attraction is sufficient to give a relatively uniform coating on all sides of the articles, even though the articles are not turned during their movement while subjected to the spray. For articles of this type and for other articles where the spray is to be applied to one side only, there is provided a construction as shown in Fig. 6 of the drawings. Each of the sprockets 31 is provided with a suitable opening in which there is inserted a pin 60, the lower end of which is received in an opening in the adjacent link of the chain 15. The pin, therefore, prevents the articles from turning during their travel through the cabinet.

When the articles on the conveyor are spaced relatively close together it is desirable that they be slowly rotated in their movement through the cabinet to insure uniform coating. For this purpose mechanism shown particularly in Figs. 3 and 4 is provided. In this construction there is provided a pair of brackets 81 secured to the plate 18, one of which brackets serves as a bearing for a vertical stub shaft 82 and the other for a similar stub shaft 83. A sprocket chain 84 is trained about a pair of sprockets 85 and 86 carried by said stub shafts. The chain 84 is of the proper pitch to mesh with the sprockets 31 carried by the carrier units 28. A plate 87 rests on brackets 88 and a bracket 89 secured to the plate 18. The edges of said plate 87 engage the inner and outer runs of the chain 84 which is preferably a roller chain adapted to run

smoothly on said edges. By movement of the plate 67 toward or away from the conveyor 15 the chain 64 may be brought into and out of mesh with the sprockets 31.

The plate 67 has secured thereto a vertical pin 70 extending downwardly through a slotted opening 71 in the bracket 69 and having secured thereto a T-fitting 72. A stud 73 is threaded in the outlet of said T-fitting and is connected to a rod 74 by a pipe union 75. Said union is loosely adjusted so that the rod 74 may be rotated without rotating the stud 73 and the threaded connection 76 therein is soldered to prevent the union becoming unscrewed in its movement. The outer end of the rod 74 is guided in a bracket 77 secured to the bracket 69. A washer 78 is carried by the rod 74 and is held in place thereon by a pin 79. A compression spring 80 is interposed between said washer and the bracket 77 and normally urges the rod 74 and associated parts to the left in Fig. 4 to keep the chain 64 in engagement with sprockets 31. The yielding pressure of the spring permits the chain to give slightly if the teeth of the sprockets do not initially engage the chain at the proper point.

The outer end of the rod 74 is provided with a T-fitting 81, in one run of which there is secured a downwardly extending handle 82 and the other of which carries a stud 83. A detent 84 is secured to a portion of the cabinet in position to engage the stud 83. A guide pin 85 secured to the bracket 69 operates in a slotted opening 86 in the plate 67 and serves to guide the movement of the same. By means of this construction, the spring 80 normally presses the plate 67 against the inner run of the chain 64 and holds said chain in engagement with the sprockets 31. By means of the handle 82 the rod 74 may be rotated so that the stud 83 clears the detent 84, the rod may then be drawn to the right in Fig. 4 and the stud 83 returned to its vertical position outside of the detent 84. In this movement the plate 67 is moved to the right in Fig. 4 and disengages the chain 64 from the sprockets 31 and the detent 84 engages the stud 83 to retain the parts in this position.

A variable speed motor 87 is connected through a reduction gear unit 88, a pulley 89 and a belt 90 to a pulley mounted on the stub shaft 62 and thus serves to move the chain 64. When the motor 87 is run at the proper speed to operate the chain 64 at the same speed as the conveyor chain 15, no rotation of the articles on the conveyor is produced. By increasing the speed of the motor 87, rotation of the articles is effected in one direction, and by reducing the speed, the direction of rotation may be reversed. Any suitable speed of rotation of the articles may thus be produced by slight variations in the speed of motor 87. Of course when rotation of the articles is to be produced the pins 60 are withdrawn.

The foregoing specification describes the invention in one of its preferred forms. It is apparent however that variations in one or more of the elements of the invention are necessary for the coating of articles of different sizes and shapes. Articles of conducting material serve as their own collecting electrodes and do not require additional collecting electrodes of large size, such as shown herein. With the high voltages used in the method, certain articles not ordinarily classed as conductors actually possess sufficient conducting power to be efficient electrodes in themselves. For example, small panels of wood have been successfully painted without the use of additional electrodes. Some articles are of such shape that they cannot be efficiently sprayed with the spray guns located as shown herein. With such articles it may even be necessary to direct the spray at right angles to their path of travel. However, even with such an arrangement of the guns other features of the invention specified in the claims are applicable.

The invention claimed is:

1. In apparatus of the class described, conveyor means adapted to move a series of articles to be coated in a predetermined path, a series of receiving electrodes movable with said articles, each of said electrodes being associated with one of said articles, a discharge electrode spaced from the path of movement of said articles and positioned so that at least a portion of each of said articles intervenes between said discharge electrode and the associated receiving electrode, electrical means producing a high potential difference between said discharge electrode and said receiving electrodes, and means for spraying a coating material into the space between said articles and said discharge electrode, said potential difference being sufficient to attract the spray particles toward said receiving electrodes and thereby deposit the same on said articles.

2. In apparatus of the class described, a conveyor, a discharge electrode spaced therefrom, a series of electro-conductive support members carried by said conveyor and each adapted to support an article to be coated with at least a portion of said article intervening between said support members and said electrode, a source of electric potential having opposite terminals connected respectively to said support members and said electrode, and means for spraying a coating material into the space between said articles and said discharge electrode, said potential difference producing an electrostatic field effective to attract the spray particles toward said support members and thereby deposit the same on said articles.

3. In apparatus of the class described, a conveyor, a discharge electrode spaced therefrom, a series of electro-conductive support members carried by said conveyor and each adapted to support an article to be coated, each of said articles wholely masking its associated support member, a source of electric potential having opposite terminals connected respectively to said support members and said electrode, and means for spraying a coating material into the space between said articles and said discharge electrode, said potential difference producing an electrostatic field effective to attract the spray particles toward said support members and thereby deposit the same on said articles.

4. In combination, a conveyor carrying a plurality of spaced articles moving successively in a predetermined path, a terminal associated with said articles, a discharge electrode spaced from the path of travel of said articles, a source of high potential connected with said terminal and electrode respectively and creating in the atmosphere therebetween an electrostatic field, and a spray gun adapted to discharge a spray of coating material into said field, the axis of said spray being inclined at an acute angle to the direction of movement of the articles such that the initial velocities of particles of different sizes are lost adjacent to said path, and said electrode and

terminal being so placed that said electrostatic field includes substantially the whole of the path of said spray, whereby spray particles varying in size and velocity are collected on said articles by electrostatic action.

5. In combination, a conveyor carrying a plurality of spaced articles moving successively in a predetermined path, a discharge electrode in the form of a relatively fine wire arranged generally parallel to the path of said articles and spaced therefrom, a source of high potential connected with said terminal and electrode respectively and creating in the atmosphere therebetween an electrostatic field, a spray gun adapted to discharge a spray of coating material into said field, the axis of said spray being inclined at an acute angle to the direction of movement of said articles such that the initial velocities of particles of different sizes are lost adjacent said path, and said electrode and terminal being so placed that said electrostatic field includes substantially the whole of the path of said spray, whereby spray particles varying in size and velocity are collected on said articles by electrostatic action.

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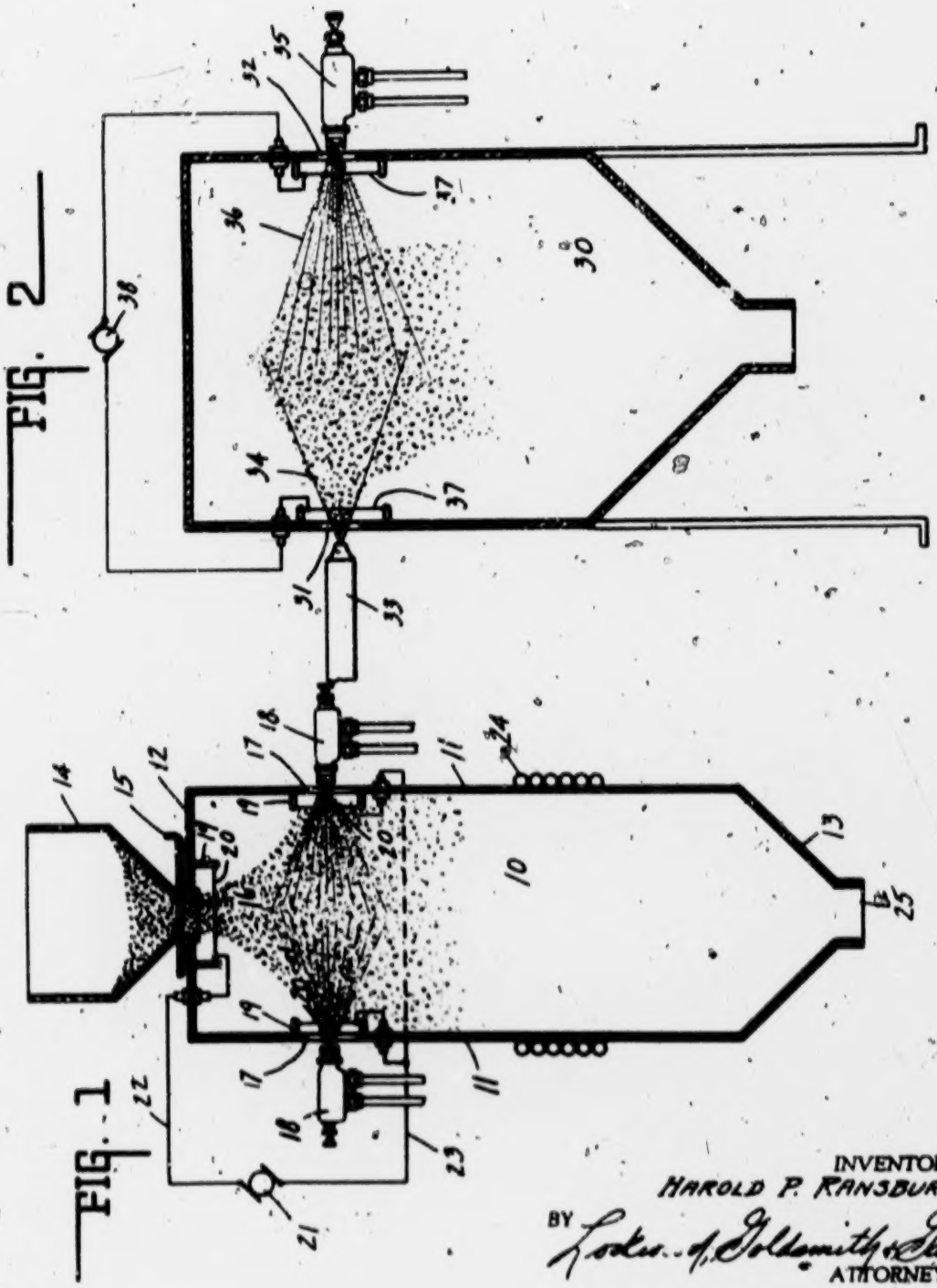
Jan. 20, 1942. H. P. RANSBURG 2,270,341

METHOD OF COATING GRANULAR MATERIALS

Filed Dec. 2, 1939 2 Sheets-Sheet 1



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METHOD OF COATING GRANULAR MATERIALS

Filed Dec. 2, 1939 2 Sheets-Sheet 2

FIG. 4

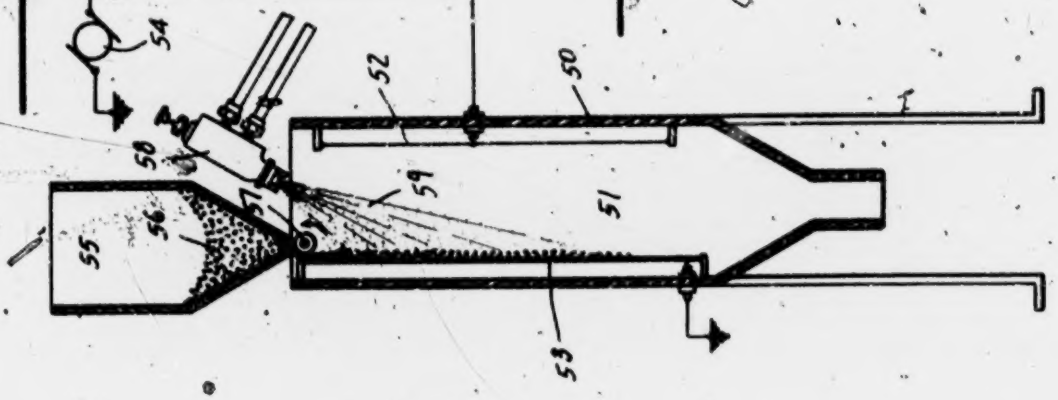


FIG. 5

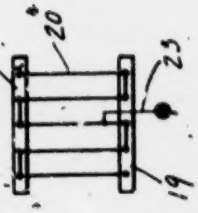
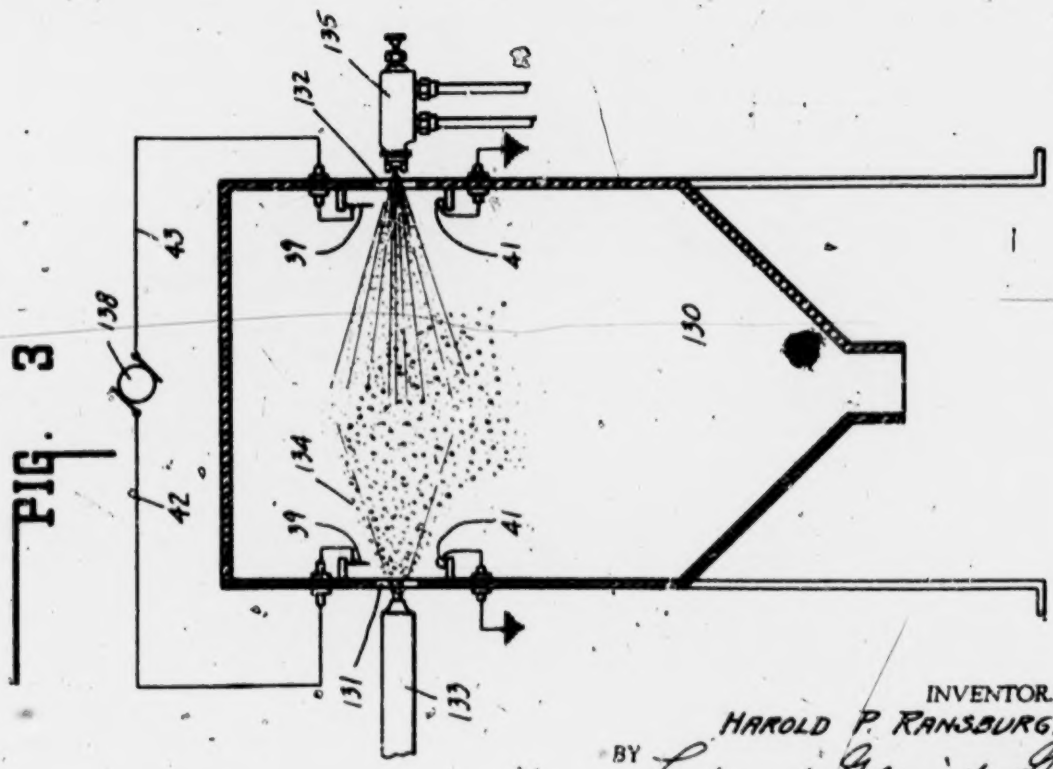


FIG. 6

FIG. 3



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METHOD OF COATING GRANULAR MATERIALS

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Application December 2, 1939, Serial No. 307,312

4 Claims. (Cl. 91—68)

This invention relates to a method of coating granular materials. The method is particularly adapted to the coating of ground cork with adhesive material for the manufacture of molded cork articles such as the cork seals used in crown bottle caps. Another use of the invention is in the coating of ground cork or other similar material with paint or coloring matter in the manufacture of press board or insulating roofing material. Many other similar uses of the invention are possible.

In the past it has been the practice to coat such granular materials by mixing the same with the coating material in a pug mill or other form of apparatus by which they are mechanically mixed. This process is not entirely satisfactory for giving a thorough and uniform coating to all particles of the granular material unless excessively long periods are allowed in the pug mill. Even with a lengthy pugging operation there is a tendency for the smaller particles to accumulate in masses coated only on the outside, the individual particles within the mass having all or a large portion of their surface uncoated. The prior process, moreover, is restricted in use since some materials can not be handled at all in that manner.

One object of the present invention is to provide a simple and efficient method of coating granular materials of the type described which insures a thorough coating of the surface of all particles.

Another object of the invention is to provide a method for coating such materials with coatings which have not been possible by the prior methods.

In its simplest form the invention provides for intermingling dispersed streams of the granular material and coating material in an electrostatic field in such manner that the particles of the coating material are directed to the particles of granular material by electrostatic attraction. In one form of the invention the electrostatic attraction is produced by impressing static surface charges of opposite potential upon the particles of the two streams. In this form of the invention like charges impressed on the particles of granular material serve to scatter the particles by electrostatic repulsion and so facilitate access of the coating material to individual particles. This in itself is of great importance even when the coating material is not electrically charged. In another form of the invention a stream of the granular material is passed over the surface of an electrode which is used to attract electrostatically a spray of coating material toward the stream of granular material.

Preferably the two streams of material are intermingled in midair while unsupported, as distinguished from spraying coating material on a stream of material travelling on a conveyor. In this way the greatest dispersion of the granular particles is obtained and all parts of each particle are accessible to the coating material.

Other objects and features of the invention will be understood from the accompanying drawings and the following description and claims:

Figs. 1, 2, 3 and 4 are vertical sectional views partly diagrammatic of several forms of apparatus by means of which the method of the invention may be carried out. Fig. 5 is an elevational view of a portion of the apparatus shown in Fig. 1. Fig. 6 is a similar view of a portion of the apparatus shown in Fig. 3.

Referring now to Fig. 1, there is provided a chamber 10 having side walls 11, top 12 and hopper bottom 13. The walls, top and bottom of the chamber are preferably constructed of an electrically non-conducting material such as plywood, fibreboard or the like. A supply hopper 14 provided with a control gate 15 communicates with the chamber 10 by means of an inlet opening 16. The supply hopper 14 is adapted to contain a supply of material to be coated which may be fed into the chamber 10 through the opening 16 and the flow of which may be controlled by the gate 15. In the upper portion of each side of the chamber 10 there is provided an opening 17 through which a coating material, such as paint, glue, varnish or other similar substances, may be sprayed, as by pneumatic spray guns 18. The spray guns 18 may be of any conventional form well known in the art and suitable for the particular coating material to be supplied. For certain materials the rapid cooling effect of expanding compressed air associated with a pneumatic spray gun is detrimental. In such cases, a well-known type of centrifugal spray device may be provided instead.

Associated with each of the openings 17 and with the opening 16 there is provided a grid construction shown particularly in Fig. 5. Said construction consists of a pair of supports 19 mounted on the wall of the chamber and carrying an electrical conductor 20 which is repeatedly passed from one to the other of the supports 19 to form a grid between the strands of which the materials must pass in entering the chamber 10. A generator 21 adapted to supply direct current at a relatively high voltage may be located at any

convenient place adjacent the apparatus. This generator preferably supplies a potential of the order of 100,000 volts and several types well known in the art are available for the purpose. One terminal of the generator is connected by a conductor 22 to the grid 20 arranged beneath the opening 16. The opposite terminal of the generator is connected by a conductor 23 to both of the grids 20 associated with the coating material openings 17. By means of this construction a high potential electrostatic field is established within the chamber 10, the portion thereof adjacent the granular material supply opening 16 being charged with one potential and that adjacent the coating material openings 17 being charged in the opposite sense. Preferably the spacing of the grids and the voltage applied thereto is properly chosen so that a corona discharge takes place, since the voltages associated with such discharge are found to have the necessary effect in charging the atmosphere adjacent the grids and the particles of material passing through the grids.

In the operation of this form of the apparatus, the gate 15 is adjusted to permit a stream of the granular material to fall freely into the chamber 10. Even though the material is not such as would ordinarily be classed as a conductor of electricity still the particles thereof may pick up surface electric charges in passing through the grid 20 and the highly charged atmosphere surrounding the same. Since like charges are picked up by the particles, they tend to repel each other and the stream of material is thereby scattered. At the same time, the particles of coating material sprayed into the chamber 10 pick up electrical charges opposite to those on the particles of the granular material. The sprays of coating material are directed as best seen in Fig. 1 to converge upon the stream of granular material and since the latter stream has become dispersed by electrostatic repulsion of its particles, each particle has a much greater chance to receive its full complement of coating material than it would have if the stream were not so dispersed. The opposite electrical charges of the particles of granular material and coating material cause the same to be attracted toward each other and to neutralize each other. An intimate mixing of the two materials and a thorough coating of the granular particles is thus immediately produced.

In certain cases it is important that the coating on the particles be thoroughly dried before the particles are brought together in a mass. For such cases, heating coils 24 may be applied to the lower portion of the chamber 10 for maintaining a relatively high temperature therein. This temperature may be maintained in many cases sufficiently high to evaporate the solvent used in the coating material. The coated particles fall to the bottom of the chamber 10 and may be discharged through an opening 25 therein for such further steps in the process of manufacture as may be necessary.

Referring now to Fig. 2, there is shown therein a second form of apparatus for carrying out the invention. In that form a chamber 30 which may be of substantially similar construction to the chamber 10 is provided with side openings 31 and 32. Adjacent the opening 31 there is a pneumatic blow gun 33 by means of which a supply of granular material 34 may be blown into the chamber 30. Adjacent the opening 32 there is a spray gun 35 which may be similar to the guns 18 and which sprays a coating material 36 into the chamber 30. The stream of granular material and the stream of coating material are directed toward each other and collide in the center of the chamber. This in itself promotes intimate mixture of the two materials. However, an even more efficient mixing is produced by the provision of grids 37 similar to the grids 20 and arranged adjacent the openings 31 and 32. Said grids are electrically charged in opposite senses by a generator 38. The operation of apparatus of this form is similar to that of the apparatus shown in Fig. 1. The stream of incoming granular material is dispersed by electrostatic repulsion and the oppositely charged particles of the two streams are electrostatically attracted to each other in much the same manner as previously described.

Referring now to Fig. 3, there is shown therein a construction similar in many respects to that of Fig. 2 and in which parts numbered in the one hundred series have the same construction and function as correspondingly numbered parts in the unit series of Fig. 2. In this construction the grids 37 are not used and are replaced by a construction shown in detail in Fig. 6. In said construction a plurality of downwardly extending electrical conductors 39 are mounted on a support 40 and are electrically connected to each other. Beneath each of the openings 131 and 132 there is mounted a conductor 41 in opposed relation to the conductors 39. The conductors 39 associated with the granular material supply opening 131 are connected to one terminal of the generator 138 by a conductor 42 and the conductors 39 associated with the coating material supply are connected to the opposite terminal of the generator by a conductor 43. Both of the conductors 41 are grounded.

By means of this construction separate electrostatic fields are set up between each of the conductors 39 and its associated conductor 41. Since the gap between said conductors is much less than half of the gap between the grids 37 of Fig. 2 the voltage required to establish corona discharge is much less. In addition, the ends of the conductors 39 constitute discharge points which intensify corona discharge. The two fields, since they are connected to opposite terminals of the generator, charge the atmosphere in their immediate neighborhoods in opposite senses so that particles of the granular material entering the opening 131 are charged in opposite sense to particles of coating material entering the opening 132. The resulting interaction of the charged particles is similar to that previously described in connection with Figs. 1 and 2.

Referring now to Fig. 4, there is illustrated an apparatus suited for the coating of materials which are not so well adapted to the reception of electrostatic surface charges. In the use of this construction, less reliance is placed upon the electrostatic attraction between the particles of the two materials and additional means are provided for directing the spray of coating material upon the stream of granular material. In this form of apparatus there is provided a casing 50 of electrical non-conducting material defining a chamber 51. Adjacent opposite sides of the chamber 50 there are provided electrodes 52 and 53 connected to opposite terminals of a generator 54 adapted to supply high voltage direct current. The electrode 52 is preferably in the form of a vertical wire having very small surface area. Electrode 53 is a plate of conducting material having many times the surface area of the

electrode 52. Above the chamber 51 there is provided a storage hopper 55 adapted to contain a supply 56 of the granular material to be coated. Said material is supplied from a suitable opening in the bottom of the hopper 55 to a rotating gate roller 57 which is adapted to regulate by its speed of rotation the flow of material from the hopper. Said material is permitted to fall freely across the face of the electrode 53 and thus passes through the electrostatic field established between the electrodes 52 and 53. A spray gun 58 is mounted to supply a spray of coating material 59 into the upper part of the chamber 51 between the stream of granular material and the electrode 52. As discussed in more detail in co-pending application of Harold P. Ransburg and Harry J. Green, Serial No. 281,766, filed June 29, 1939, coating material sprayed into an electrostatic field is attracted to the electrode having the largest surface area in much greater degree than toward the electrode of small surface area. Thus the spray of coating material is attracted to the electrode 53 but is intercepted by the stream of granular material dispersed over the surface of the electrode and is intimately mixed therewith.

Several forms of apparatus by means of which the method of the invention as defined in the appended claims may be carried out have been described. Other forms will be apparent to those skilled in the art.

The invention claimed is:

1. A method of coating granular material comprising establishing an electrostatic field between two spaced points, introducing a stream of the material to be coated in the neighborhood of one of said points, introducing a stream of liquid coating material in the neighborhood of the second of said points whereby said streams are electrically charged in opposite sense, and directing said streams to convergence within said field whereby particles of one stream are attracted to particles of the other.

2. A method of coating granular material comprising establishing a corona electric discharge between a pair of oppositely charged electrodes, and introducing converging streams of said material and a coating material into the space between said electrodes, one of said streams passing sufficiently close to one of said electrodes to receive electrical charges therefrom and the other similarly receiving charges from the other of said electrodes, whereby particles of one stream are attracted to particles of the other.

3. A method of coating granular material comprising spraying said material and coating material into an electrostatic field said streams entering said field through oppositely charged portions thereof and converging within said field.

4. A method of coating granular material comprising establishing an electrostatic field of high potential between two electrodes one of which has a surface area many times greater than the other, passing a freely falling stream of said material between said electrodes and close to the larger electrode, and spraying coating material into the space between said stream and the smaller electrode, said coating material being electrostatically attracted toward said larger electrode and thereby mingling with the stream of material to be coated.

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Oct. 3, 1944. C. K. GRAVLEY 2,359,476

ELECTROSTATIC METHOD AND APPARATUS

Filed Jan. 15, 1940 2 Sheets-Sheet 1

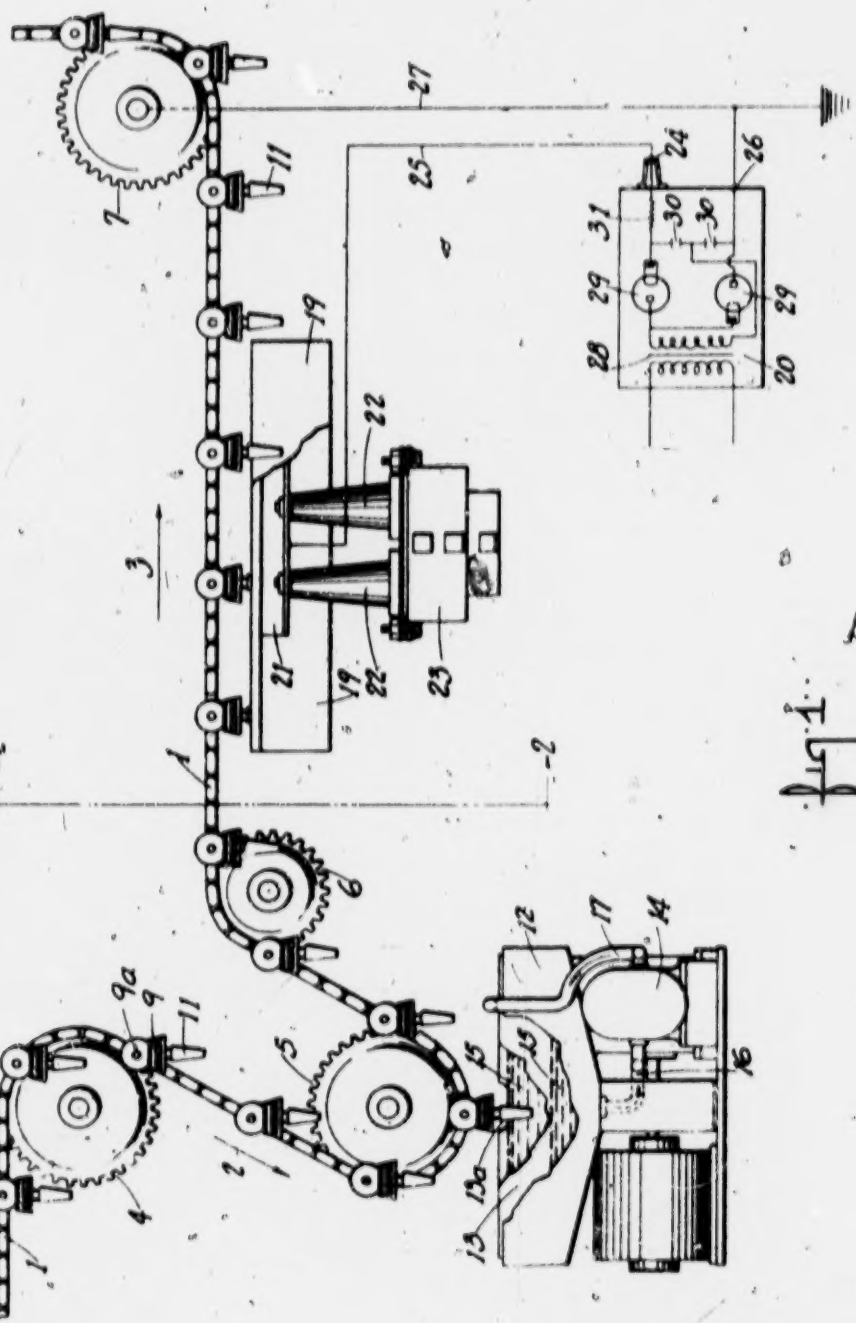

Fig. 1.

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ELECTROSTATIC METHOD AND APPARATUS

Filed Jan. 15, 1940 2 Sheets-Sheet 2

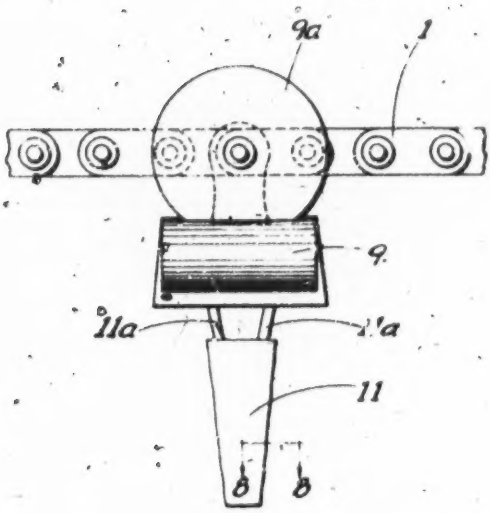

Fig. 3.

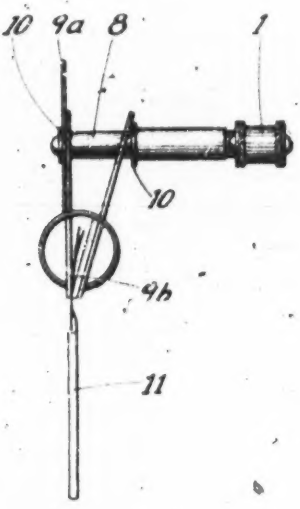

Fig. 4.

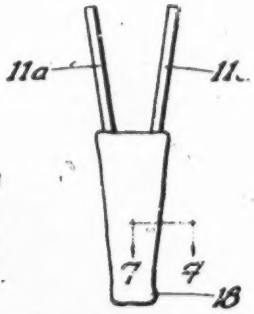

Fig. 5.

Fig. 6.

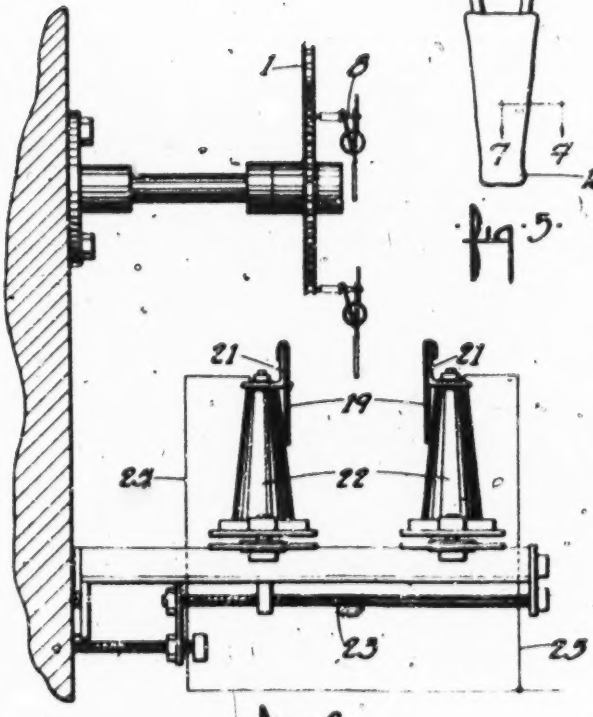

Fig. 2.

Fig. 7.

Fig. 8.

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2,359,476

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UNITED STATES PATENT OFFICE

2,359,476

ELECTROSTATIC METHOD AND APPARATUS

Charles K. Graviey, Cleveland, Ohio, assignor, by mesne assignments, to Harper J. Ransburg Company, Indianapolis, Ind., a copartnership consisting of Harper J. Ransburg, H. Gregg Ransburg, Harold P. Ransburg, and Edwin M. Ransburg

Application January 15, 1940, Serial No. 313,914

27 Claims. (Cl. 117—93)

This invention relates to a method and apparatus for coating articles with paint, varnish, lacquer or other coating materials.

An object of this invention is to provide an improved method for coating articles.

A more specific object is to provide a method for obtaining an improved distribution of coating material on the coated article.

A further object of this invention is to provide a method for removing the drop or drops of coating material that usually accumulate at the bottom of an article in the coating process.

Another object of this invention is to provide a method for obtaining a heavier coating at corners and edges of an article.

A further object is to provide apparatus for attaining the above objects.

The invention is applicable to the coating of articles of various kinds, sizes and shapes wherein the coating is applied in the liquid state and subsequently dries or sets. It has been developed in connection with the coating of piezoelectric units and will be described chiefly in connection with the coating of such units, but it should be understood that the invention is merely illustrated by this application, and is not restricted thereto.

Piezoelectric units, especially of the Rochelle salt type such as are used in microphones, phonograph pickups, etc., may be adversely affected by such atmospheric conditions as very high or very low humidity, high temperatures, etc., and for this reason are usually coated with a protective material such as lacquer or shellac. Two difficulties have been encountered in coating such units by the usual dipping or spraying methods. Firstly, part of the coating material tends to run to the lowermost part of the unit and collect there in a large drop. If this drop is not removed it subsequently hardens into a lump which is unsightly and may interfere with the mounting of the unit or the attachment thereto of a part such as a phonograph stylus holder. Such drops have heretofore been removed by a wiping process which could not be practiced effectively with automatic coating machinery. The second difficulty has been to obtain satisfactory coating thickness on sharp corners and edges. Most coating materials tend to favor flat surfaces by drawing away from the corners and edges. Consequently the coating material is thinnest at the locations which are most easily damaged.

I have discovered that the above difficulties can be greatly reduced and a desirable distribution of coating material obtained by subjecting the coated article to the influence of an electrostatic force while the coating material is in a wet state. For example, the article after being coated by spraying or dipping may be supported between metal electrodes, or above an electrode, or both. I usually prefer to use the article itself as one electrode and establish a difference of potential on the order of a few hundred to several thousand volts between the article and the adjacent electrodes. The resulting electrostatic force causes the excess coating material to leave the object and produces a more uniform distribution of the coating material which remains. The excess material may be removed in one or two large drops or in a large number of fine drops or even in a practically atomized state, depending on the nature of the material and the voltage used. In general, a higher voltage tends to remove the material in smaller drops or particles. It has been observed that the material leaves an article from sharp points such as the lowermost corners.

By thus using electrostatic force to remove the excess coating material it is possible to obtain a more uniform distribution of material than if gravity alone is relied on. I have also observed that the distribution of coating material which remains on the article is improved in another respect by the action of the electrostatic field, this improvement resulting from the tendency of the material to build up in thickness at sharp corners and edges. When the additional protection which is afforded by this increased thickness is desired, it may be secured by keeping the coated article under the influence of the electrostatic field until after the coating material has become set; that is, until after the material has reached that state or condition wherein it will henceforth hold its shape while drying. This provides additional protection at the regions most subject to damage.

When the coating material in a wet state is a reasonably good conductor of electricity and when the material is conductively connected to the source of high potential such as is the case when the coated article is of metal and connected to a high potential source, the source may be of either alternating or direct current. When the coating material is a very poor conductor, better results are obtained by the use of direct current. It appears that for poor conductors the conductivity between the electrode and the outer parts of the coating is so poor that said outer parts do not have time to become

charged to a sufficient potential before the cycle has reversed, whereas with the direct current there is no reversal of the potential and therefore considerable time may be allowed for a suitable charge to reach the outer portions. In the interest of safety for the operator, it is usually desirable to use a direct current source although this requires somewhat more elaborate equipment. The reason for this is that when a direct current source is used a very large protective resistance may be built into the power supply, which resistance makes it impossible for a fatal amount of current to flow through a person's body if he should accidentally come in contact with the electrodes. On the other hand, if alternating current is used, the alternating current necessary to charge the electrodes may in some cases cause so great a voltage drop in the series protective resistance that sufficient potential may not be obtained at the electrodes.

To further explain the invention I will now describe a practical form of automatic apparatus suitable for carrying out the new method in connection with the coating of small objects such as piezoelectric units.

Referring to the drawings,

Fig. 1 is a front elevation of a portion of a conveyor system and associated apparatus suitable for use with my improved method.

Fig. 2 is a sectional view taken on line 2, 2 of Fig. 1.

Fig. 3 is a front elevation of a portion of the conveyor holding a piezoelectric unit which has been coated by my new method.

Fig. 4 is an end elevation of the part shown in Fig. 3.

Figs. 5 and 6 are front and side elevations respectively of a piezoelectric unit as it appears when coated without benefit of my improved method, or as it appears before being subjected to the influence of the high-voltage electrostatic force.

Fig. 7 is an enlarged fragmentary sectional view of a portion of the piezoelectric unit of Fig. 5 and taken on line 7, 7.

Fig. 8 is an enlarged fragmentary sectional view of a portion of the piezoelectric unit of Fig. 3 and taken on line 8, 8.

Referring to the figures, the conveyor comprises a roller chain 1 which is guided in the direction of arrows 2 and 3 by sprockets 4, 5, 6 and 7, and is kept in motion by a suitable motor and reduction gear not shown.

At intervals along its length the conveyor chain is provided with extended pins 8, 8 which carry spring clips 9, 9, each provided with an enlarged handle portion 9a and a rubber compression pad 9b. The clips are free to rotate on pins 8 and are held in place by collars 10, 10. The leads 11a, 11a of the piezoelectric units 11, 11, are clipped into the clips by an operator positioned somewhat to the left of sprockets 4 and 5.

Below sprocket 5 is located a double tank comprising reservoir 12 containing an inner level-controlling tank 13. A motor driven pump 14 pumps the liquid coating material 15 out of reservoir tank 12 through pipe 16 and into level-controlling tank 13 through pipe 17, so that tank 13 continuously overflows at 13a back into main tank 12, thus maintaining a constant level of liquid as determined by the lower edge of cut out 13a in tank 13.

As the conveyor progresses in the direction indicated by the arrows 2 and 3, each piezoelectric unit 11 is successively dipped in the tank and then withdrawn. As the units are withdrawn from the tank the excess coating material tends to accumulate at the lower portions of the units under the action of gravity as indicated at 18 in Figs. 5 and 6.

To prevent accumulation of excess coating material at the bottom of the units and to assist in coating the edges and corners, I provide electrodes 19, 19 and a source of high voltage 20 connected to the electrodes and to the conveyor. Electrodes 19 are removably supported by angle members 21, 21 which are carried by high voltage insulators 22, 22. A frame 23 supports the insulators and is constructed to permit adjustment of the height and spacing of the electrodes. The high potential terminal 24 of the power supply 20 is connected by conductors 25, 25 to angle members 21 which are in contact with the electrodes. The low potential terminal 26 of the power supply is connected to ground and to the conveyor system by conductor 27 and therefore is also connected to the conductive coating of the piezoelectric unit.

As the coated piezoelectric units 11 approach the electrodes 19 the electrostatic forces established by the high potential causes the excess coating material 18 to be drawn off to the electrodes usually in a fine stream or spray. The excess continues to be drawn off until the coating material which remains on the article has reached a condition where it no longer flows in response to the electrostatic force. The material is then in such condition that it will henceforth hold its shape without forming drips, and hence has become set. Figs. 3 and 4 show the element after the coating material has thus become set while subjected to the action of the high voltage. The high potential field also tends to force the coating material to edges and corners. This is illustrated by Figs. 7 and 8 which are enlarged sectional views of the elements of Figs. 5 and 3 respectively, showing in exaggerated detail the distribution of coating material at the edges of the unit before and after the treatment with the electrostatic field. It will be observed (Fig. 7) that prior to application of the high voltage field the coating material tends to pull away from the edges leaving a very thin coating in the region that should have the greatest protection. However, when the electrostatic force is applied the coating material is caused to build up at the edges, thus providing the desired additional thickness at those regions, as shown in exaggerated form in Fig. 8. The electrodes 19, 19 of course are long enough to permit the coating material to become set in this built-up condition before the units pass beyond their influence. The units are then carried back and forth by the conveyor through a drying chamber (not shown) to permit more thorough drying and then pass to successive dipping tanks and removing electrodes where additional coats are applied. After the last coating applied to the units has become dry, the units are removed from the clips by another operator and are ready for final test and use.

It has been found that a plurality of thin layers of coating material provides more satisfactory protection for piezoelectric units than a single thick layer. Heretofore it has been expensive to apply a plurality of coats because each coat has been applied by hand and the excess coating material wiped off after each coating step. My invention eliminates the necessity for handling the units individually each time a coating layer is applied, and thus permits the appli-

cation of a plurality of layers without additional cost. A further advantage of the use of a plurality of coats is that the different kinds of coating material may be used for the different layers. For example, it has been found that the vinyl chloride composition known to the trade as Korolac is an excellent moistureproofing material but does not adhere well to piezoelectric units. Black shellac has good adhering properties but is not as effective in protecting the units. By using shellac for the first two or three coats and then by using a coat or two of Korolac, very effective protection is obtained. Without the aid of my invention such a composite, built-up protective coating would be excessively expensive.

The voltage required for satisfactory operation of the invention depends on a number of factors of which the surface tension of the coating material and the spacing of the coated object from the electrodes are perhaps most important. In general, the greater the surface tension of the coating material, the greater the required voltage becomes. Also, the greater the spacing between the coated article and the electrodes, the greater the voltage required. For the electrode arrangement shown in Figs. 1 and 2, with the electrodes spaced about 2" from the coated article, a voltage in the order of 10,000 to 20,000 volts is desirable when thin black shellac is the coating material. The effect of this voltage may be markedly increased by adding materials like acetonyl acetone to the shellac for the purpose of reducing its surface tension.

Approximately the same results may be obtained with lower voltage and closer electrode spacing but the possibility of short circuits occurring due to swinging of the coated units over to an electrode becomes more serious. Voltages which produce a visible or audible discharge should be avoided.

It will be understood that many other arrangements of parts may be employed. For example, in lieu of the pair of vertical electrodes 19, 19, a single horizontal electrode may be placed beneath the conveyor. This arrangement provides for satisfactory removal of excess coating material but has the disadvantages, when used for coating piezoelectric units, that the effective electrode spacing depends on the length of the units being treated. Another arrangement is to use the tank of coating material as an electrode. With this arrangement, if the coating material is a conductor, the system is short circuited every time an article is dipped and it is necessary to arrange the spacing of the units on the conveyor so that a dipped unit is removed from the tank and subjected to the removal action of the high potential before the next unit enters the tank. This arrangement is hazardous when used with inflammable coating material, but the hazard may be avoided effectively by maintaining an inert atmosphere around the coating tank.

I prefer to use the coated article as one electrode of the system whenever this is possible because I have had best results with this arrangement. When it is desired to use a coated non-conducting article as one electrode, this may be accomplished, for example, by suspending the non-conducting article from a wire or hook which is connected to one side of the voltage source, the other side thereof being connected to an adjacent electrode. With this arrangement, a coating material should be used which is a conductor when in a wet state. The dipping step should then be conducted in such manner that the hook or wire contacts the coating material. The conductive coating on the article will then function as an electrode.

It should be understood that it is not essential that the coated article be connected to the high-voltage source, since it has been found that the coated article, whether a conductor or not, may be treated by merely introducing it in an electrostatic field which is maintained between two electrodes of opposite polarity.

The high voltage supply, 20, as shown comprises a step-up transformer, 28, two thermionic rectifiers, 29, 29, and condensers, 30, 30, connected in a voltage doubling circuit. Resistance, 31, in the order of 20 megohms is connected in series with the high potential side to limit short circuit currents to a safe value. This high resistance cooperates with the capacity of the electrodes and wiring to provide smoothing or filtering action.

Other types of high voltage supplies may, of course, be used. For example, the thermionic rectifiers may be replaced by mechanical rectifiers, or the complete supply, 20, may be replaced by an electrostatic generator. Furthermore, in many cases an alternating current supply may be used comprising simply a step-up transformer. Transformers intended for use with neon signs are comparatively inexpensive and are suitable for this use.

Since various changes may be made in the above construction and different applications of the invention could be made without departing from the scope thereof, it is intended that all matters contained in the above description or shown in the drawings shall be interpreted as illustrative and not in a limiting sense.

Having now explained my invention, what I claim is:

1. The method of treating an article which comprises the steps of coating said article with liquid coating material and thereafter allowing said liquid coating material to become set while under the influence of an electrostatic force.

2. The method of treating an article which comprises the steps of applying liquid coating material to said article, subjecting said coated article to the action of an electrostatic force while said coating material is in a liquid condition to remove the excess therefrom and to redistribute the liquid material which remains and maintaining said article under the influence of said force until the coating becomes set.

3. The method as claimed in claim 2 wherein the said liquid coating material is applied by dipping.

4. The method of increasing the thickness of coating on the edges of a coated article, which comprises the step of subjecting said coated article to an electrostatic force while the coating material is in a liquid condition, and maintaining the article under the influence of said force until the coating material has become set.

5. The method of removing excess liquid coating material from an article coated therewith and for increasing the thickness of coating on the edges of the article, said method comprising the steps of: subjecting the coated article to an electrostatic field while allowing the excess material on said article to drain by gravity to the bottom portions of the article; and maintaining the article in said field until the coating has become set.

6. The method of treating an article, which comprises the steps of: coating said article with

liquid coating material; subjecting the coated article to the action of an electrostatic force while the coating material is still liquid; and thereafter allowing said liquid coating material to become set while under the influence of said electrostatic force.

7. The method of removing liquid coating material from an article which is coated with an excess thereof, said method comprising the steps of: bringing the coated article into spaced relationship with respect to an electrode; establishing an electrostatic field between said article and electrode while said excess coating material is sufficiently liquid to drain by gravity to the bottom portions of the article; and maintaining said field until the coating material which remains on the article has become set.

8. The method of treating an article which comprises the steps of: coating said article with an excess of liquid coating material; causing the excess coating material to flow over the surface of the article and to accumulate on predetermined surface portions thereof; subjecting at least the said predetermined portions to the influence of an electrostatic field while the accumulations of coating material are still liquid; and maintaining the article under the influence of said field until no further accumulations of coating material appear adjacent said predetermined portions.

9. The method of treating an article, which comprises the steps of: coating said article with an excess of liquid coating material; causing the excess coating material to flow over the surface of the article and to accumulate on predetermined surface portions thereof; passing at least the said predetermined portions into an electrostatic field maintained between a pair of electrodes while the accumulations of coating material are still liquid; and maintaining said portions under the influence of said field until no further accumulations of coating material appear thereon.

10. A method of treating a piezoelectric unit, said method comprising the steps of: coating said unit with an excess of liquid shellac; subjecting the coated unit to the influence of an electrostatic field while the shellac is still liquid and until it has become set; drying said coating of shellac; thereafter coating said unit with an excess of liquid waterproofing vinyl resin; and resubjecting the unit to the influence of an electrostatic field while the resin is still liquid and until it has become set.

11. In the process of coating an article with liquid coating material, the method of preventing the accumulation of drops of excess coating material at the bottom portions of said article, which comprises subjecting at least said portions of the coated article to the influence of an electrostatic force while said coating material is in a liquid state and until it has become set.

12. Apparatus for treating an article having a coating of liquid coating material thereon, said apparatus comprising the combination of: means for establishing an electrostatic field capable of removing drops of excess coating material from said article, and means for subjecting said article to the action of said field while the coating material is still liquid and until it has become set.

13. Apparatus for coating an article with liquid coating material, said apparatus comprising: means for applying the liquid coating material to the article; an electrode; means for establishing an electrostatic field between said article and electrode; and means for disposing said article adjacent said electrode while said coating material thereon is in a liquid state and for maintaining it adjacent said electrode until the liquid coating material has become set.

14. Apparatus for coating an article, which comprises: a bath of liquid coating material; electrode means; conveyor means adapted to dip said article in said bath, then to transport said dipped article into predetermined spaced relationship with respect to said electrode means while the coating on said article is in a liquid condition, and then to maintain it in said spaced relationship with said electrode until the coating material has become set; and electrical means for establishing an electrostatic force between said coating and said electrode means capable of removing the excess liquid coating material which drains to the bottom portions of the article.

15. The method of making a coated article which comprises the steps of: dipping said article in liquid coating material, and then subjecting the dipped article to the action of an electrostatic force while the coating thereof is in a liquid state.

16. The method of removing a portion of a coating from an article comprising the steps of establishing a potential difference in a circuit, connecting one side of the circuit to the article to establish the article and the coating thereon at substantially the same potential, and connecting the other side of the circuit to terminal means spaced from the article to cause a portion of the coating to leave the article and move through the space toward the terminal means.

17. The method as claimed in claim 16 in which the article is maintained at substantially ground potential.

18. The method as claimed in claim 16 in which said established potential difference is maintained by a direct current source.

19. The method as claimed in claim 16 in which said coating is a liquid coating.

20. Apparatus for treating an article comprising in combination; means for coating said article with an excess of coating material, means for establishing a direct current potential difference, open electrical circuit means connected to said means for establishing said direct current potential difference, means for connecting one side of said circuit to said coated article to establish said article and said coating at substantially the same potential, and said open circuit including means spaced from said coated article and maintained at a potential different than the potential of the article and the coating thereon to cause the excess portion of said coating to leave the article and move through the space toward said spaced means, and current limiting impedance means located between said means for establishing the direct current potential difference and said means which are spaced from said coated article.

21. Apparatus for coating an article with liquid coating material, said apparatus comprising: means for applying the liquid coating material to the article; an electrode; means for establishing an electrostatic field between said article and electrode; and means for disposing said article adjacent said electrode while said coating material thereon is in a liquid state and for maintaining it adjacent said electrode.

22. Apparatus for coating an article, which comprises: a bath of liquid coating material;

electrode means; conveyor means adapted to dip said article in said bath, then to transport said dipped article into predetermined spaced relationship with respect to said electrode means while the coating on said article is in a liquid condition, and then to maintain it in said spaced relationship with said electrode; and electrical means for establishing an electrostatic force between said coating and said electrode means capable of removing the excess liquid coating material which drains to the bottom portions of the article.

23. The method of removing surplus coating material from a pre-coated article that comprises, imparting an electric charge to said surplus, and subjecting such charged surplus to an electric field of proper polarity and of sufficient strength to cause the said surplus to leave the article.

24. Apparatus for treating a coated article comprising, in combination, a high potential source, means for connecting one side of said high potential source to the coated article, electrode means spaced from said article, means connecting said electrode means to the other side of said high potential source to establish a steep potential gradient between said electrode means and said article whereby excess coating material is caused to leave said coated article.

25. Apparatus for treating a coated article comprising in combination, a plurality of spaced terminal means, means connected to at least one of the terminal means for establishing a high potential difference between said terminal means, and means for electrically connecting said coated article to one of said terminal means to subject the coating to the electrostatic force established by said potential difference to cause a portion of the coating to leave the article.

26. In an apparatus for treating a coated article; circuit means including a voltage source for establishing a potential difference in said circuit means, means for connecting one side of the voltage source to the article to establish the article and the coating thereon in the circuit and to establish the coating thereon at a certain potential, electrode means spaced from said coated article, and means for connecting the other side of the said voltage source to the said electrode means to establish the electrode means in the circuit and at a potential different from the potential of the coating to cause portions of the coating to leave the article.

27. Apparatus for treating a pre-coated article, comprising in combination a plurality of spaced apart electrodes, means for giving one of said electrodes a high potential with respect to another of said electrodes, and means for disposing a coated article effectively in the electric field between said electrodes and in [redacted] contact with one of said electrodes whereby excess coating material is expelled from said article.

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1123

March 18, 1947. H. P. RANSBURG ET AL 2,417,798

APPARATUS FOR COATING ARTICLES

Filed June 25, 1943 3 Sheets-Sheet 1

FIG. 1

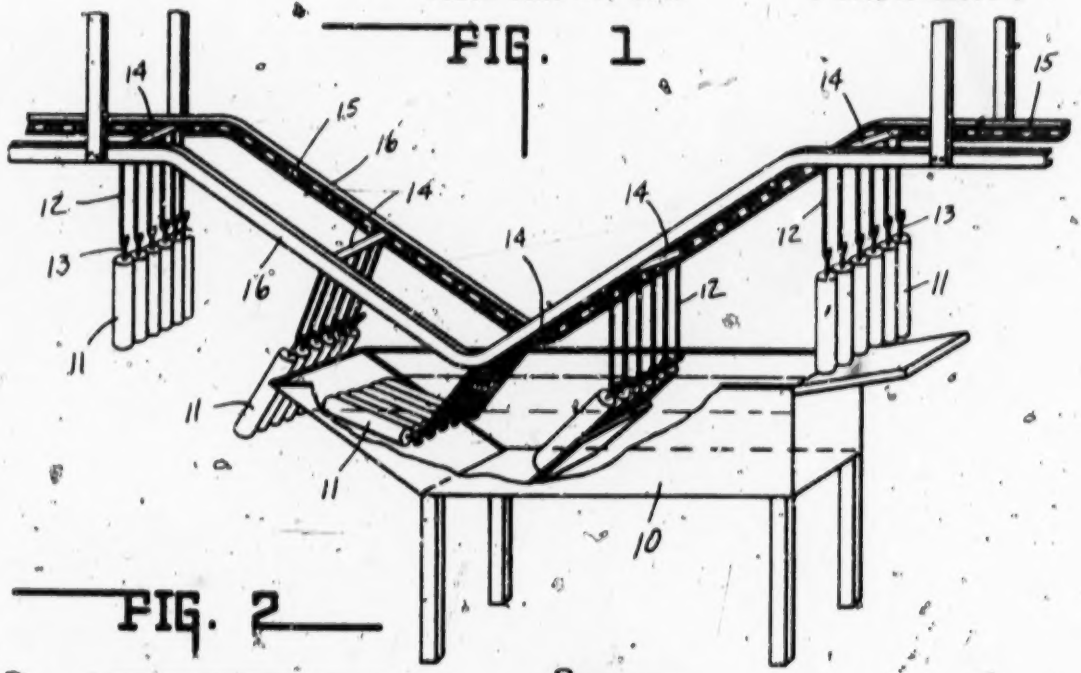
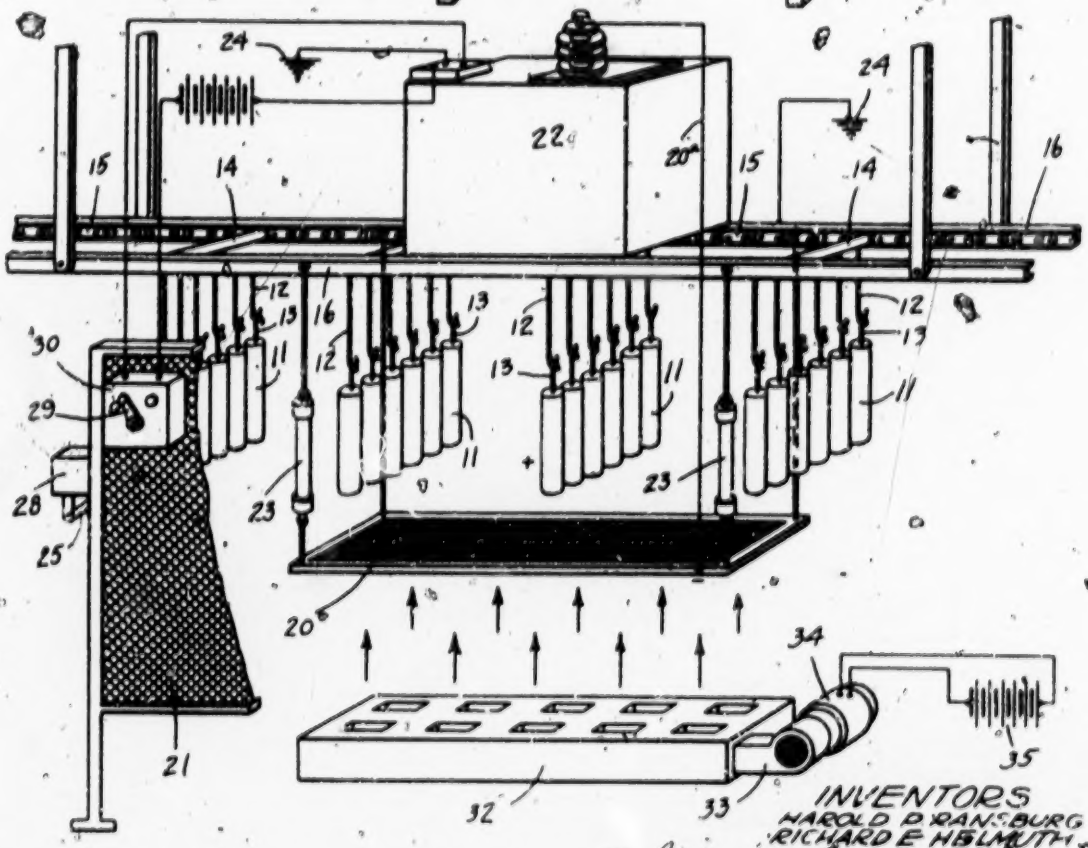


FIG. 2



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March 18, 1947. H. P. RANSBURG ET AL 2,417,798

APPARATUS FOR COATING ARTICLES

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FIG. 3

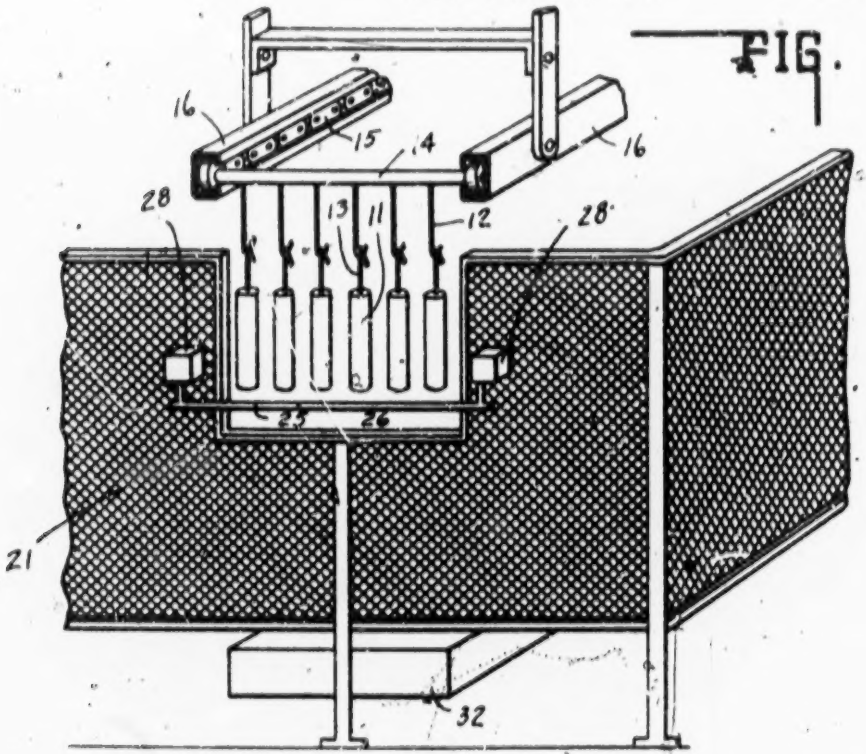
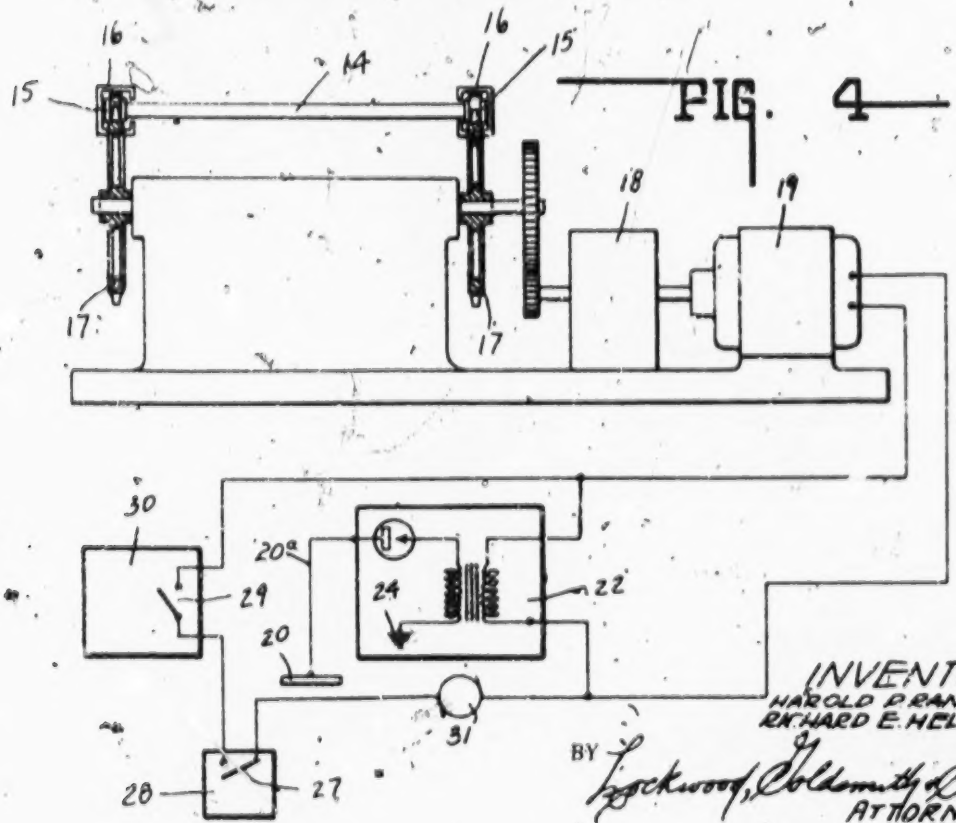


FIG. 4



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APPARATUS FOR COATING ARTICLES

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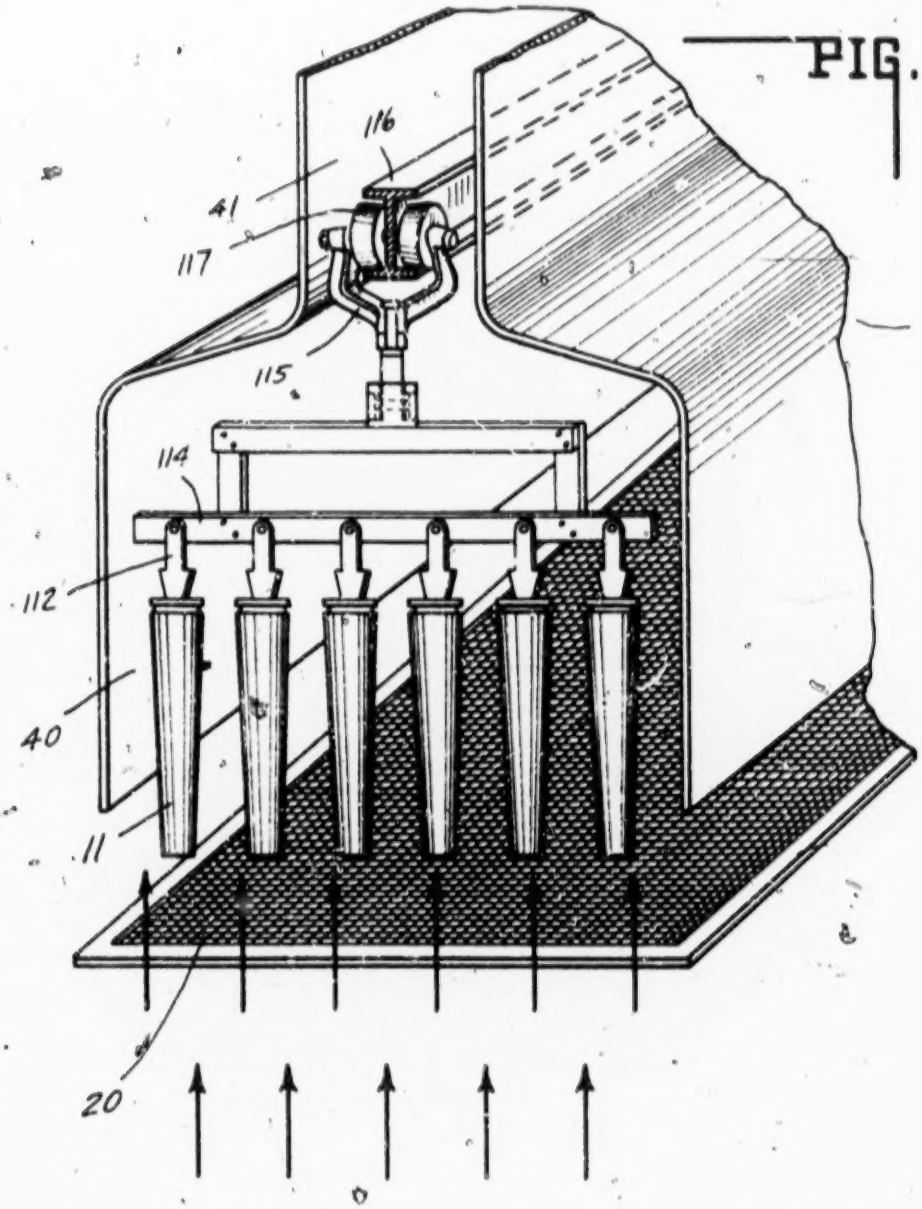
FIG. 5



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Patented Mar. 18, 1947

2,417,798

1129

UNITED STATES PATENT OFFICE

2,417,798

APPARATUS FOR COATING ARTICLES

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Application June 25, 1943, Serial No. 492,204

18 Claims. (Cl. 91—18)

1

This invention relates generally to apparatus for coating articles with the aid of an electrostatic field as set forth in a general way in Letters Patent of Charles K. Gravley No. 2,359,476 granted October 5, 1944, entitled "Electrostatic method and apparatus," and Letters Patent of Ransburg and Green No. 2,247,963 granted July 1, 1941, entitled "Apparatus for spray coating articles."

This invention more particularly relates to improved coating apparatus and safety features incorporated therein.

It is the purpose of this invention to provide certain safety apparatus which will insure prevention of the gases being ignited, and thereby render entirely safe and practical the carrying out of the coating process or method as set forth in the above mentioned Letters Patent.

Another purpose of this invention is to obtain an improved coating on articles by properly combining the forces of the electrostatic field and the force of gravity.

Another purpose of this invention is to minimize further flow of the coating material following the detearing action.

Still further purposes and advantages will become apparent both by direct recitation thereof and by implication from the context as the description proceeds.

One feature of the invention resides in the provision of an electric circuit control by which the apparatus will function only when there is sufficient space or gap between the coated article and the electrode effective in conjunction therewith to provide the electrostatic field, to prevent any danger of such space or gap being so reduced as to be bridged by a spark. This is accomplished by providing a control member, such as a switch actuating bar, contact wire or electric eye in a plane so spaced from the plane of the electrode as to insure that articles clearing it will pass the electrode in such spaced relation that a spark will not occur therebetween. If any article carried through the field is of such size or so supported as to otherwise pass close enough to the electrode to create a spark, it will first actuate a switch control which will stop the conveyor and shut off the power by reason of engagement with the switch bar, wire or affecting the circuit of the electric eye.

For the purposes hereinafter discussed, a blower is so mounted in respect to the electrode as to constantly carry any volatile gases developed from coating of the articles passing thereby, away from the electrode. By means of the draft created by the blower, accumulation of volatile

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gases between the articles and the electrode will be dissipated and carried away so as to prevent an accumulation of an explosive mixture of solvent vapor, eliminating the possibility of ignition in case a spark should occur.

A further feature of the invention resides in the provision of an apertured electrode plate, such, for example, as may be formed of expanded metal. This arrangement is particularly advantageous when the electrode extends under the articles being processed whereby an induced air current may pass upwardly therethrough in the manner and for the purposes herein described. The advantage of the apertured electrode plate extending in a plane below the travel of the articles may well be appreciated when it is understood that the electrostatic forces may then be developed to be co-directional with the forces of gravity. This arrangement of the electrode plate below the articles results in the elimination of "flow lines," smoothing down the surface and facilitating the removal of gravity flowed "tear drops."

A further advantage of the induced draft resides in its effect upon the coating material causing it to take a set simultaneously with the action of the electrostatic field in removing "tear drops," "fatty edges" and other gatherings of excess coating. This has the effect of preventing "runs" or additional accumulations thereafter.

Particularly in the case of hollow articles, we have found it is of advantage to remove the volatile gases entrapped therein. Otherwise the coating will remain fluid and not take its set during the processing. This difficulty is overcome by the induced draft directed into the interior of the article so as to dissipate the gases and permit timely setting of the coating.

The full nature of the invention will be understood from the accompanying drawings and the following description and claims:

Fig. 1 is a diagrammatical illustration in perspective showing one method of coating the article before entering the electrostatic field. Fig. 2 is a diagrammatical illustration in perspective showing the articles entering and passing through the electrostatic field embodying the safety factors of this invention. Fig. 3 is a diagrammatical illustration in perspective showing the entrance gate with one type of circuit control mounted thereon. Fig. 4 is a schematic drawing showing the conveyor drive and control circuit. Fig. 5 is a modified form of that portion of the invention for directing air current past the coated articles.

For illustration, the invention is herein shown

and described as applied to articles coated by dipping them in a bath of coating material such as lacquer. However, various other types of coating, such as paints, varnishes and similar finishes may be applied by dipping the article in a bath thereof or by spraying or the like. The invention is also described herein as applied to that type of apparatus wherein the articles are continuously conveyed through the electrostatic field by a horizontally moving conveyor above the electrode, although the invention is similarly applicable to conveyors of the type wherein the article may be conveyed vertically through the electrostatic field with one or more electrodes spaced laterally therefrom.

As illustrated herein in Fig. 1, there is shown a dipping trough 10 containing a bath of coating in liquid form through which groups of articles 11 are submerged and drawn. Said articles may comprise cylindrical shell casings to be lacquered, carried in groups or batteries suspended from a conveyor by hangers 12 through the medium of the hooks 13 engaging in the center percussion holes of the closed end of the casing, and wherein the open end of the casing is at the bottom. The hangers 12 are carried by a cross bar 14 having its ends supported by opposed conveyor chains 15 running in the channel iron tracks 16. The conveyor chains are driven in any suitable way, such as by the sprockets 17 which in turn are driven through reduction gears 18 by an electric motor 19, whereby there would be a slow uniform movement of the articles through the bath, electrostatic field and drier.

As shown in Fig. 1, the conveyor tracks dip down so as to cause the oncoming articles to engage the forward end of the dipping trough and tilt downwardly into the bath so as to eliminate air pockets within the interior of the articles.

As shown in Fig. 2, the conveyor carries the articles from the dipping trough into and through the electrostatic field to effect removal of excess coating and "tear drops." The passage of the articles through the electrostatic field is at such speed that they will remain in the field until the excess coating has been removed and that remaining on the articles has become sufficiently set to prevent further flow. Said field comprises essentially a high voltage electrode in the form of a wire mesh screen 20 which may be surrounded by a protective fencing 21. The electrode is preferably of the width of the group of articles, and of a length predetermined by the time element above referred to. It receives a negative charge of high voltage through the power line 20a connected with one terminal of the power pack 22. The electrode is suspended by short insulators 23 from the channel iron tracks 16 at a predetermined distance below the lower end of the articles, such as will be effective to create the desired field in connection therewith while sufficiently spaced to prevent a spark jumping the gap therebetween. The power pack 22 has its other terminal grounded as at 24, while the tracks 16 are similarly grounded. Thus, a circuit of high voltage created by the power pack is broken only by the gap between the articles 11 and the electrode 20, the articles 11 receiving a positive charge in respect to the negative plate through the grounded track 16, cross bar 14, hangers 12 and hooks 13.

To prevent any possibility of an oversize article, hook or hanger causing an article so grounded to pass too closely to the electrode 20, there is provided a control member here shown as a trip bar 25, across the entrance gate 26 of the fence 21. The trip bar extends across the gate in a plane sufficiently spaced from the plane of the electrode to prevent any sparking between an article passing thereabove and the electrode. The trip bar is mounted to actuate a switch 27 contained in a switch box 28 which is in series with the master switch 29 in a control box 30. The switch 27 is normally closed, being opened only in event one of the articles 11 strikes the trip bar 25. The switch then remains open until closed by removal of the oversize article. When opened, the circuit is broken through the power pack and the conveyor motor 19 so as to bring the operation to a stop until the condition is corrected. As shown in Fig. 4, the power pack 22 and motor 19 are connected in parallel and through the switches 27, 29 with a source of power indicated at 31. Similarly, the switch 27 or 29 may be actuated by other known means for opening the circuit through the power pack or motor as by a contact wire or "electric eye." Also, in some instances if dripping from the articles interferes with the trip bar or the like by accumulation thereon, it may be positioned in advance of the dipping or coating operation instead of at the entrance to the electrostatic field.

Immediately below the articles 11 passing over the electrode, as shown herein, there is positioned an apertured air duct 32 provided at one end thereof with a blower in the blower housing 33, driven by the motor 34 from a source of power indicated at 35. The apertures in the air duct are so arranged as to direct a forced draft of air upwardly with respect to the articles so as to dissipate any accumulation of explosive gases given off by the solvent of the coating material, whereby the electrostatic field will be kept clear of such gases.

In the modified form of Fig. 5, there is illustrated an arrangement whereby a natural draft is developed about the coated articles by passing them through a hood 40 open at the bottom and terminating at the top in a restricted passage or flue 41. By reason of the restricted flue, in this case a single I-beam support 116 is provided by which the carrier 115 is conveyed and guided through the flue 41 by the rollers 117, the articles 11 being suspended from the cross bar 114 by hangers 112. A draft of air, indicated by arrows, may be drawn upwardly past the articles either by natural draft due to the flue 41 or by an exhaust fan connected at the outlet thereof, as may be desired. Thus, any accumulation of volatile gases under and about the articles will be carried away so as not to present an explosive atmosphere between the articles and the electrode 20.

In the above described arrangements, an apparatus is provided in which the probability of sparking due to the high voltage of the electrodes is reduced to a minimum.

Another advantage is the elimination of gravity flowed "tear drops," which permits of an improved finish on the coated article.

Still another advantage is the simplicity with which ignition hazards are reduced by the removal of solvent vapor accumulation from the electrostatic field.

The invention claimed is:

1. Apparatus for coating a series of articles with liquid coating material including an evaporating solvent capable of producing explosive gases, said apparatus comprising means for applying liquid coating to said articles, an electrode, means for establishing an electrostatic field be-

tween said articles and electrode, a conveyor for conveying said articles into said electrostatic field past said electrode in predetermined spaced relation thereto, and means controlled by the position of one of said articles relative to said electrode before entering the electrostatic field for rendering said apparatus inoperative where said article upon entering said field would so closely approach said electrode as to induce a spark therebetween.

2. Apparatus for coating a series of articles with liquid coating material including an evaporating solvent capable of producing explosive gases, said apparatus comprising means for applying liquid coating to said articles, an electrode, means for establishing an electrostatic field between said articles and electrode, a conveyor for conveying said articles into said electrostatic field past said electrode in predetermined spaced relation thereto, and means positioned at the entrance to said electrostatic field operable by one of said articles entering said field to render said apparatus inoperative where the path of travel of said article is such that upon entering said field it would so closely approach said electrode as to induce a spark therebetween.

3. Apparatus for coating a series of articles with liquid coating material including an evaporating solvent capable of producing explosive gases, said apparatus comprising means for applying liquid coating to said articles, an electrode, means for establishing an electrostatic field between said articles and electrode, a conveyor for conveying said articles into said electrostatic field past said electrode in predetermined spaced relation thereto, means positioned at the entrance to said electrostatic field operable by one of said articles entering said field to render said apparatus inoperative where the path of travel of said article is such that upon entering said field it would so closely approach said electrode as to induce a spark therebetween, and means for inducing a current of air directed past said electrode for dissipating and removing the accumulation of explosive gases.

4. Apparatus for coating a series of articles with liquid coating material including an evaporating solvent capable of producing explosive gases, said apparatus comprising means for applying liquid coating to said articles, an electrode, means for establishing an electrostatic field between said articles and electrode, a conveyor for conveying said articles into said electrostatic field past said electrode in predetermined spaced relation thereto, means positioned at the entrance to said electrostatic field operable by one of said articles entering said field to render said apparatus inoperative where the path of travel of said article is such that upon entering said field it would so closely approach said electrode as to induce a spark therebetween, an air duct positioned with respect to said electrode and articles to direct a current of air past said articles and away from said electrode to dissipate and remove any explosive gases accumulated therebetween, and a blower for forcing air through said duct.

5. Apparatus for coating a series of articles with a liquid coating material including an evaporating solvent capable of producing explosive gases, said apparatus comprising means for applying the liquid coating material to said articles, an elongated electrode, means for establishing an electrostatic field between said articles and electrode, a conveyor for continuously conveying said articles past said coating means into said electrostatic field and past said electrode in spaced relation thereto, an electric motor for driving said conveyor, an electric circuit for controlling said motor and the means for establishing said field, and a member disposed at the entrance to said field operable by any one of said articles extending beyond a predetermined position with respect to said electrode for opening said circuit and rendering the apparatus inoperative where said article would otherwise so closely approach said electrode as to permit of sparking therebetween.

6. Apparatus for coating a series of articles with a liquid coating material including an evaporating solvent capable of producing explosive gases, said apparatus comprising means for applying the liquid coating material to said articles, an elongated electrode, means for establishing an electrostatic field between said articles and electrode, a conveyor for continuously conveying said articles past said coating means into said electrostatic field and past said electrode in spaced relation thereto, an electric motor for driving said conveyor, an electric circuit for controlling said motor and the means for establishing said field, and a switch control member mounted at the entrance to said field in a plane of predetermined spaced relation to the plane of said electrode operable by any one of the articles extending beyond said plane to open said circuit and render the apparatus inoperative.

7. Apparatus for coating articles with a liquid coating material, said apparatus comprising means for dipping said articles in a bath of said coating material, means for conveying said dipped articles over a predetermined path with said coating material in a liquid state, an openwork electrode plate extending in a plane below and spaced from the path of travel of said articles, and means for establishing an electrostatic field between said articles and electrode plate whereby the electrostatic forces of said field are substantially co-directional with the forces of gravity for effecting an even downward flow of said liquid coating material and the removal of excess material accumulating at the bottom of said articles.

8. Apparatus for coating articles with a liquid coating material embodying an evaporating solvent adapted to give off explosive gases, said apparatus comprising means for dipping said articles in a bath of said coating material, means for conveying said dipped articles over a predetermined horizontal path with said coating material in a liquid state, an openwork electrode plate extending in a plane below and spaced from the path of travel of said articles, means for establishing an electrostatic field between said articles and electrode plate whereby the electrostatic forces of said field are substantially co-directional with the forces of gravity for effecting an even downward flow of said liquid coating material and the removal of excess material accumulating at the bottom of said articles, and means for inducing an upwardly directed current of air through said electrode about said articles while being conveyed through said field for removing and dissipating accumulated gases to permit timely setting of said coating.

9. Apparatus for coating articles comprising means for applying coating material to the surface thereof, a conveyor operable to convey said articles through space to permit partial drainage of said coating by force of gravity, an openwork electrode disposed below and in spaced relation to the path of travel of said articles over the

plane of which they are adapted to pass during their travel through said space, and electrical means for providing an electrostatic force between said articles and electrode capable of establishing an electric force in addition to the force of gravity for drawing excess liquid coating material downwardly from said articles.

10. Apparatus for coating articles comprising means for applying a liquid coating material to the surface thereof, means operable to convey said articles through space to permit drainage of said coating by force of gravity, a horizontally disposed openwork electrode mounted to extend below and in spaced relation to the path of travel of said articles, and electrical means for providing an electrostatic force between said articles and said electrode capable of establishing an electric force exerted in the same direction as the force of gravity and in addition thereto drawing excess liquid coating material downwardly from said articles.

11. Apparatus for coating articles comprising a tank containing a bath of coating material, a conveyor operable to submerge said articles in said bath and thereafter convey them beyond said tank, an openwork electrode spaced from said tank extending in a plane below and in spaced relation to the path of travel of said articles, and electrical means for providing an electrostatic force between said electrode and articles capable of drawing excess liquid coating material downwardly therefrom.

12. Apparatus for coating a series of articles with liquid coating material including an evaporating solvent capable of producing explosive gases, said apparatus comprising means for applying liquid coating to said articles, an electrode, means for establishing an electrostatic field between said articles and electrode, a conveyor for conveying said articles into said electrostatic field past said electrode in predetermined spaced relation thereto, and contact means located in predetermined relation to the conveyor and in advance of said electrode adapted to be contacted by said article for rendering said apparatus inoperative before the field between said article and said electrode rises to the point of creating a spark therebetween.

13. Apparatus for coating articles with a liquid coating material embodying an evaporating solvent adapted to give off explosive gases, comprising means for bathing said articles with said material, means for suspending said bathed articles with said coating material in a liquid state, an openwork electrode plate extending in a plane below and spaced from said articles, means for establishing an electrostatic field between said articles and electrode plate, whereby the electrostatic forces of said field cooperate with the forces of gravity for effecting an even flow of said liquid coating material over the surface of said articles, and means for inducing an upwardly directed current of air past said electrode and about said articles while suspended in said field for removing and dissipating accumulated gases to permit timely setting of said coating material.

14. Apparatus for coating articles with a liquid coating material, said apparatus comprising means for bathing said articles with said coating material, means for suspending said articles while said coating material is in a liquid state, an electrode extending in a plane below and spaced from said articles, means for establishing an electrostatic field between said articles and electrode, one or more insulators attached to said electrode, and supporting means to which said insulators are in turn attached, the point of attachment of each insulator to said supporting means being located above the lower portion of said articles, whereby at least that portion of each insulator adjacent said supporting means will be out of the path and free of accumulation of such coating material as may be removed from said articles by the forces of said electrostatic field and gravity.

15. Apparatus for coating an article with a liquid coating material embodying a volatile solvent, said apparatus comprising means for applying an excess of the coating material to the article, an electrode, a conveyor for conveying said article through association with said applying means and then past and in spaced relation to said electrode while said coating is still in a liquid state, means for establishing an electrostatic field between the electrode and article as the latter moves past the electrode, and means for creating an air stream flowing through said field to remove volatilized solvent therefrom.

16. Apparatus for coating a series of articles with liquid coating material including a volatile solvent capable of producing explosive gases, said apparatus comprising means for applying liquid coating to said articles, an electrode, means for establishing an electrostatic field between said articles and electrode, a conveyor for conveying said articles into said electrostatic field past said electrode in predetermined spaced relation thereto, a power-source for said field-establishing means and conveyor, switch means associated with said power source, and a switch-operating means connected to said switch and disposed at the entrance to said field for actuation by one of said articles when it is positioned to extend beyond a predetermined position relative to said electrode for rendering the apparatus inoperative when said article upon entering said field would so closely aproach said electrode as to induce a spark therebetween.

17. Apparatus for coating articles with a liquid coating material including an evaporating solvent adapted to give off explosive gases, said apparatus comprising means for dipping said article in a bath of said coating material, an electrode, means for establishing an electrostatic field between said article and electrode, said first mentioned means acting to convey said article into said electrostatic field past said electrode in predetermined spaced relation thereto, a power-source for said field-establishing means and said first mentioned means, switch means associated with said power source, and a switch-operating means connected to said switch and disposed at the entrance to said field for actuation by one of said articles when it is positioned to extend beyond a predetermined position relative to said electrode for rendering the apparatus inoperative when said article upon entering said field would so closely approach said electrode as to induce a spark therebetween.

18. Apparatus for coating a series of articles with a liquid coating material including a volatile solvent capable of producing explosive gases, said apparatus comprising an elongated electrode, means for establishing an electrostatic field between said article and electrode, a container for a supply of liquid coating material, a conveyor for carrying said articles through said supply of coating material into said electrostatic field and past said electrode in spaced relation thereto, an electric motor for driving said conveyor, an ele-

tric circuit including a switch for controlling said motor and the means for establishing said field, and a switch control member mounted at the entrance to said field in a plane of predetermined spaced relation to the plane of said electrode operable by any one of the articles extending beyond said plane to open said switch and render the apparatus inoperative.

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RICHARD E. HELMUTH.

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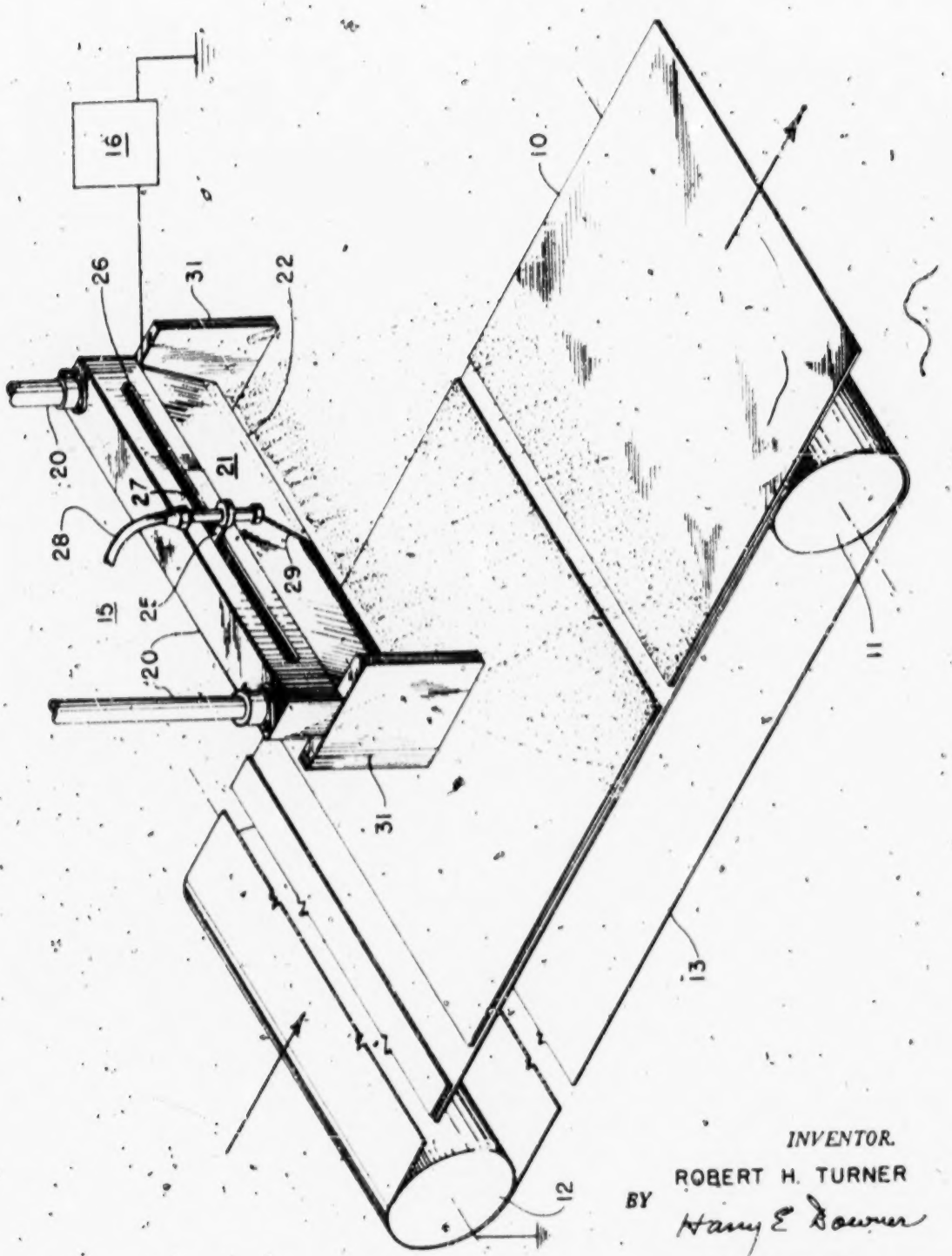
1135

Sept. 8, 1953 R. H. TURNER 2,651,287

ELECTROSTATIC COATING APPARATUS

Filed March 10, 1949



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UNITED STATES PATENT OFFICE

2,651,287

ELECTROSTATIC COATING APPARATUS

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Application March 10, 1949, Serial No. 80,753

7 Claims. (Cl. 118—51)

1

This invention relates to electrostatic deposition of liquid coating materials and more particularly to an improved coating apparatus in which the liquid coating material is both electrostatically atomized and electrostatically deposited upon an article to be coated.

In apparatus employed for electrostatically applying a liquid coating to discrete articles, it is common to move the articles through a coating zone in which the coating is applied to them. Similar practice is followed in the electrostatic coating of sheet material, the coating being applied as the sheet moves progressively through a coating zone.

In prior electrostatic applications where an elongated applicator head or discharge member has been used, some difficulty has been experienced due to the concentration of field strength at the ends of such discharge heads or members and the consequent fanning out of the jet of coating material away from the article to be coated. Such fanning out causes uneven coating and may result in the loss of coating material.

It is an object of this invention to overcome the disadvantages heretofore attendant upon the electrostatic atomization and deposition of coating material from an elongated discharge head. More particularly, it is an object to facilitate the attainment of a uniform distribution of coating material onto an article being coated, and to prevent scattering of coating material particles at one or both ends of the spray pattern created when liquid coating material is atomized from an elongated head. A further object of the invention is to confine the effective electrostatic field by utilizing one or more end plates or end members in electrostatic coating apparatus for achieving improved coating results.

The novel features that I consider characteristic of my invention are set forth with particularity in the appended claims. The invention itself, however, both as to its organization and operation, together with additional objects and advantages thereof, will best be understood from the following description of a specific embodiment of my invention when read in connection with the accompanying drawing which is an isometric view illustrating a coating apparatus in accordance with my invention.

In the drawing, I have illustrated an arrangement of apparatus suitable for coating sheet material 10. Such apparatus embodies a conveyor comprising rollers 11 and 12 and belt 13 which is adapted to move the sheet material through a coating zone. Either or both rolls 11 and 12

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may be suitably connected to a driving means such as an electric motor not shown. While the conveyor here shown is adapted to handle sheet material, it is understood that conveyor mechanism adapted to carry discrete cylindrical objects or any other suitable objects are equally adapted for use with my invention. Disposed on one side of the path of material movement through the coating zone is a horizontally disposed atomizing device 15 from which the liquid coating material is electrostatically atomized. To effect atomization of the coating material and electrostatic deposition thereof on the sheet material 10 as it passes the device 15, an electrostatic field of appropriate strength is maintained between the device 15 and the sheet material. For this purpose, the sheet material may be grounded in any suitable manner such as through the roller 12 and belt 13 as shown while the device 15 is connected to one terminal of a high voltage source 16, the other terminal of which is grounded.

The atomizing device 15 comprises supporting structure 20 to which there is affixed in any convenient manner an elongated member 21 which is preferably of electrically conducting material and connected to the ungrounded terminal of high voltage source 16. The member 21 is shaped in cross section to present toward the article 10 a relatively sharp or attenuated edge 22. An average potential gradient in excess of 3,000 volts per inch and preferably in the neighborhood of 8,000 volts per inch average potential gradient is maintained between the member 21 and the sheet material 10 moving past it, and as a result an electrical discharge will exist along the edge 22 so that liquid coating material fed to such edge will be electrostatically atomized and electrostatically deposited onto the sheet material 10. The coating material is fed to the edge 22 in the form of a film extending along the edge between more or less definite limits, such film being created and maintained by any suitable distributing means. One such means may comprise a lever 25 mounted for horizontal reciprocation in slot 26 of support 20 and between appropriate guide means not shown. This lever may carry at its end a short length of tube or pipe 27 disposed transversely of the lever. One end of the tube 27 is connected as through a flexible hose 28 with a source of coating material which is adapted to be fed to the tube 27 either by gravity or by positively produced pressure. To the opposite end of the tube 27, there is connected a nozzle 29 having its outer end disposed close to the edge 22 of the discharge device but spaced rearwardly

a short distance from such edge so as to be electrically shielded thereby. The means employed to reciprocate the lever 25 and the nozzle 29 may take various forms. One such means is shown and described in application Serial No. 57,260 of Edwin M. Ransburg, filed October 29, 1948.

As previously stated, where an elongated applicator head or member is used the end portions of the jet or spray issuing therefrom waver erratically. This results in scattered dispersion of the particles composing these parts of the jet thereby causing the deposited pattern to be irregular and uneven and also may result in the loss of some of the coating particles. My invention is directed to improved apparatus for overcoming these objectionable characteristics in order to secure a spray pattern of improved uniformity and definition. In this improved apparatus, the elongated member 21 is provided with a field-modifying member 31 located on the member 21 beyond one or each end of the film thereon and projecting forwardly from the edge 22 toward the article to be coated. In most instances, the field-modifying members 31 will be located at the ends of the elongated member 21 and desirably project laterally therefrom at the sides as well as forwardly toward the article. In one device which was built and which operated satisfactorily at a potential of 80,000 volts and with the edge 22 ten inches from the article being coated, the members 31 extended two inches beyond the cross-sectional extremities of the applicator head. The members 31 may be made either of electrical insulating or electrical conducting material, but members of electrical conducting material have a more pronounced confining result on the effective electrostatic field than members of electrical insulating material.

By the use of the members 31, I have been able to diminish the tendency of the spray from an elongated head to fan out at its ends, and have thereby been able to obtain more concentrated and uniform coating as well as better definition of the deposited pattern at its ends.

What I claim is:

1. In an electrostatic atomizing device for use in the electrostatic deposition of liquid coating material on an article, a discharge head having an elongated member of electrically conductive material provided with an elongated, rectilinear edge, means for supplying liquid coating material to said edge, two field-modifying members provided on said head and comprising a pair of plates secured to said head normal to said edge, with each plate having a portion projecting laterally from said elongated member and forwardly from said edge, said plates being located at points adjacent to and beyond the opposite ends of the liquid at said edge, means for connecting the discharge head to a source of high electrical potential to create between said head and the article an electrostatic field sufficient to atomize coating material supplied to said edge and to move the same toward the article, and means for supporting the head in opposed relationship to the article and at a distance sufficient to permit substantial dispersion of the atomized particles during their movement toward the article.

2. Apparatus for coating an article comprising, in combination, an atomizer having an elongated discharge edge to which liquid is supplied as a film for atomization therefrom, means including a high voltage source for establishing between the article and liquid on said discharge edge an electrostatic field having a potential difference sufficient to atomize the liquid and move the atomized particles toward said article in the form of a spray, means for supporting the article in opposed relation to the atomizer and at a sufficient distance to permit substantial dispersion of the atomized particles during their movement toward the article, and a field modifying member supported adjacent said discharge edge, said field-modifying member terminating in an extended edge which projects forwardly of said discharge edge toward said article and into the peripheral portion of the field to compress said portion of the field.

3. The invention set forth in claim 2 with the addition that said field modifying member is made of electrically insulating material and is maintained in the same electrical relationship to the article as is the atomizer.

4. In an electrostatic coating system, an atomizing device for use in the electrostatic deposition of liquid coating material on an article comprising a discharge head having an elongated edge, means for supplying liquid coating material to said edge as a film for atomization therefrom, means for causing relative movement between said head and the article, means for creating an electrostatic charge differential between the atomized particles and an article electrostatically to deposit the particles on the article, and field modifying means secured to said head with a terminal portion projecting beyond said elongated edge and located adjacent to and beyond the extremities of the liquid on said edge.

5. In an electrostatic coating system, an atomizing device for use in the electrostatic deposition of liquid coating material on an article comprising a discharge head having a member of electrically conductive material provided with an elongated edge, means for moving the article in a predetermined path adjacent said edge, means for supplying liquid material to said edge and for forming the material into a film thereat for atomization from an edge of the film, means for creating an electrostatic charge differential between the coating material particles atomized from said edge and the article to form therebetween an electrostatic field for moving the atomized particles of coating material through quiescent air and depositing them on said article, and a field modifying member positioned in fixed relationship to said head and provided with at least two spaced portions located adjacent to and projecting beyond said elongated edge to compress the peripheral portions of said depositing field.

6. Apparatus for coating an article comprising, in combination, an atomizer supported in opposed spaced relationship to an article to be coated and having a discharge member, means for supplying liquid coating material to said atomizer, means including said discharge member for forming the material fed to said atomizer into a film having an elongated edge for atomization from said edge, means for causing relative movement between the article and the atomizer, means including an electrode adapted to be connected to a high voltage source for establishing between the article and the coating material particles atomized from the atomizer an electrostatic field having a potential difference sufficient to move the particles through quiescent air toward the article for deposition thereon, with the spacing between said atomizer and the article being sufficient to permit substantial dispersion

of the particles during their movement toward the article, and a field-modifying member having an end portion, said end portion projecting forwardly of said edge to constrict the depositing field at the location of said end portion.

7. Apparatus for coating an article comprising, in combination, an atomizer supported in opposed spaced relationship to an article to be coated and having a discharge member, means for supplying liquid coating material to said atomizer, means including said discharge member for forming the material fed to said atomizer into a film having an elongated edge for atomization from said edge, means including a high voltage source for establishing between the article and the coating material particles atomized from the atomizer, an electrostatic field having a potential difference sufficient to move the liquid particles through quiescent air toward the article for deposition thereon, with the spacing between said atomizer and the article being sufficient to permit substantial dispersion of the particles during their movement toward the article, and field-modifying means having at least two portions supported to project in opposed relationship forwardly of said edge to constrict said field at the location of the projecting portions.

ROBERT H. TURNER.

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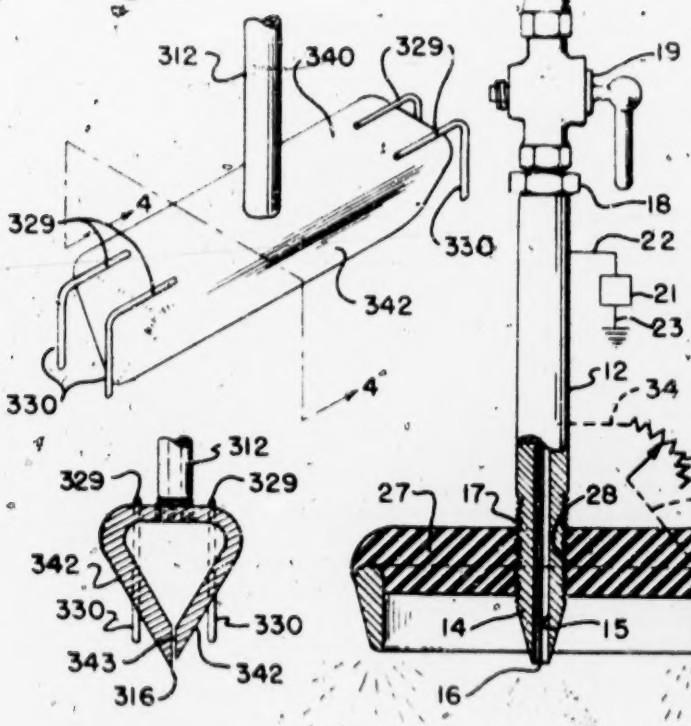
Nov. 3, 1953 E. M. RANSBURG 2,658,009

ELECTROSTATIC COATING METHOD AND APPARATUS

Filed May 13, 1948

Fig. 3



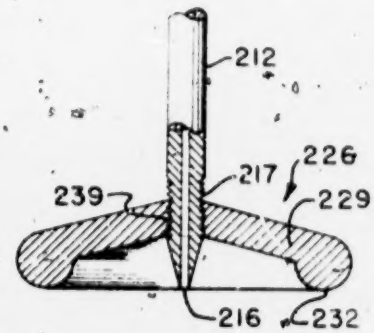


Fig. 2

Fig. 4

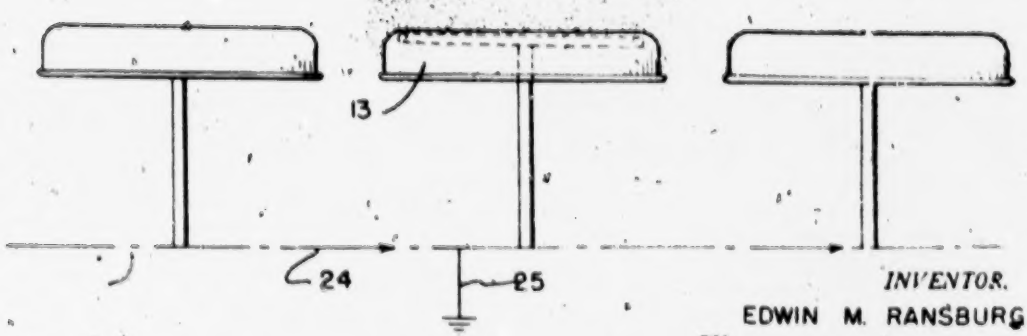


Fig. 1

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ELECTROSTATIC COATING METHOD AND APPARATUS

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Application May 13, 1948, Serial No. 26,867

10 Claims. (Cl. 117—93)

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This invention relates to the application of liquid coating to articles by electrostatically atomizing, projecting and depositing the coating upon the articles within an electrostatic field created between the articles and an issuing source of the coating material. This general process of applying coatings is disclosed in the U. S. applications of William A. Starkey et al., Serial No. 556,390, filed September 29, 1944, William W. Crouse, Serial No. 13,174, filed March 5, 1948, and William W. Crouse, Serial No. 141,509, filed January 31, 1950, said application Serial No. 13,174 being now abandoned. The invention is particularly directed toward providing greater stability to the projected spray or jet and imparting a sharper edge definition to its issuing pattern.

In such electrostatic coating process as generally practiced, the article to be coated is supported in opposed spaced relation to a sharp edged electrode between which and the article a potential difference of sufficient magnitude is maintained to create an electrostatic field with an atomizing corona discharge in the region adjacent said edge. The coating material is arranged to be supplied to the edge and its region of corona discharge at a rate no greater than that at which it can be electrically atomized by the corona discharge, whereupon the charged particles are projected in spray form toward and deposited upon the oppositely charged article. In certain instances, possibly due to fluctuations in intensity of the corona discharge perhaps caused by minute imperfections at different portions of the electrode edge or for other reasons, the projected jet is unstable in the sense that its axis wanders erratically or shifts from one position to another while also varying in cross-sectional shape. Instability in the direction and form of the jet results in an undesirable, irregular scattering of the coating material upon the surface of the article. Since each particle composing the jet is charged to the same electrical sign, the inherent electrical repulsion effect causes the particles to spread laterally from each other.

This spreading action is more noticeable at the outer portions of the jet and results in an irregular, uneven and indistinct edge definition to the pattern of the coating material as deposited upon the article. I have discovered that by surrounding in close proximity the atomizing, projecting and depositing electrostatic field with a secondary electrostatic field that is substantially coextensive, longitudinally with the former, the projecting spray jet is stabilized, is made more

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definite in shape and more constant in direction, and the scattered spreading effect upon the particles, particularly at the outer portions of the jet, is materially reduced. This results in a deposited pattern which is more uniformly dense throughout and which has a sharp edge definition.

It is an object of the present invention to provide in an electrostatic method and coating apparatus of the character above set forth, a secondary stabilizing field adjacent the electrostatic spray atomizing, projecting and depositing field that is effective to stabilize the jet produced by the latter, both directionally and in respect to shape, and to give a resulting deposited pattern which has a relatively sharper edge definition, either throughout its entire periphery or over one or more portions of its periphery.

It is a further object of the invention to provide a method and apparatus of this character in which the atomizing projection in jet form, deposition and control of the jet—all three—are accomplished by a single form of energy. This adds materially to the simplicity and efficiency of the method, to compactness, smoothness and quietness of operation, and low cost of the apparatus for practicing it.

A further object of the invention lies in the provision of a simply constructed, unitary and inexpensive spray head for an electrostatic coating apparatus of the character set forth.

These and other features of the invention will be best understood and appreciated from the following description of various embodiments selected for purposes of illustration and shown in the accompanying drawings in which:

Fig. 1 is a side elevation of one form of the improved elecstrotatic atomizing apparatus with the secondary, stabilizing field control electrode mounted on the atomizing head and illustrates diagrammatically the general arrangement of the head in the electrical circuit and its disposition with respect to the articles to be coated.

Fig. 2 is a side view, partly in section, showing a modified form of said head and secondary field producing electrode.

Fig. 3 is an isometric view of a modified form of head with a correspondingly modified form of secondary field producing electrode, such head and electrode being adapted to disperse an extended, elongate wedge-shaped jet in contra-distinction to the generally conically formed jets produced by the types of heads illustrated in Figs. 1 and 2, and

Fig. 4 is a sectional elevation taken along the line 4—4 of Fig. 2.

Referring to Fig. 1, the apparatus comprises a length of relatively small diameter (on the order of ⅜" O. D.) tubing 12, preferably of electrically conducting materials. Tube 12 is arranged to be supported in any suitable manner in spaced relation with its longitudinal axis disposed at substantially right angle to the surface of the article 13 to be coated and with its nozzle or tip end 14 projecting toward the article. The nozzle or tip 14 is formed by beveling the outer surface of the tube from a point adjacent the end, gradually toward the end and toward the interior surface of the bore 15 (the bore being of a diameter on the order of ⅛"), thus providing a continuous, annular edge 16 of knife-like sharpness. Adjacent the beveled tip 14, the tube is threaded exteriorly as at 17 for a short distance of its length for a purpose later to be described. The opposite end of the tube is connected to a valve coupling 18 having a hand operated valve 19 which is suitably connected by means of tubing 20 to the supply source of the liquid coating material (not shown), that is to electrostatically atomized, projected and deposited upon the article 13. The source of liquid material may be disposed at an elevation above the tube so that the liquid feeds by gravity through the bore 15 or, if desired, it may be fed under pressure by compressed air or the like to the bore 15 through which it is conducted to the discharge edge 16. The rate of flow of the coating material to the edge 16 should preferably be no greater than that which can be electrically atomized, whether such rate of flow is established by gravity or pressure feed or both.

A source of high voltage illustrated diagrammatically at 21 has one of its terminals connected by a conductor 22 to the tube 12 and its opposite terminal connected by a conductor 23, either directly to the conveyor 24 upon which the articles to be coated are mounted or to ground. In the event the conductor 23 is connected to ground, a conductor 25 may be connected from ground to the conveyor as shown. The voltage source 21 is preferably capable of producing voltages of unidirectional current upwardly from 22 kv. to 125 kv. With a voltage of 60 kv. applied to the tube, with its knife-like discharge edge 16 at a distance of approximately 14 inches from the surface of the article to be coated, it has been found that corona discharge will be formed in the region adjacent said edge of an intensity which is sufficient to break up or atomize into particled form the coating material which is being fed to said edge and project said coating material in a generally conical spray form toward the surface of the article being coated. The electrostatic field established between the discharge edge 16 and the surface of the article further imparts an electrical charge to each particle and causes the electrostatic deposition of the projected, atomized coating material onto the surface of the oppositely charged article.

As previously stated, under certain conditions possibly due to fluctuations in the brush or corona discharge, perhaps because of minute imperfections at different portions of the edge 16 or for other reasons, the projected jet wavers erratically and continuously, first at one angle and then another. This results in a scattered dispersion of the particles composing the jet and thereby causes the deposited pattern upon the article to have irregularly disposed lobes. In addition, the mutual electrical repulsion of the particles due to their being charged to the same sign causes them to spread and scatter laterally and particularly at the outer portions of the jet. This makes for a less sharply defined edge at the boundary of the deposited pattern. To overcome these objectionable characteristics, I provide a secondary field surrounding in close proximity the electrostatic atomizing field and coextensive in length with the latter. By coextensive I mean extending from an electrode having an edge which is supported substantially coplanar with but in spaced relation from the corona discharge atomizing edge to and terminating at the surfaces of the articles to be coated.

The means for effecting the establishment of a secondary field consists of an electrode or control member 26 which utilizes the electrostatic forces created by high voltage source 21 to create said secondary electrostatic field in the gaseous medium surrounding the jet. Control member 26 is comprised of a disk 27 of electrically nonconductive material having a centrally disposed bore 28 which is threaded to screw onto the thread 17 adjacent tip 14. The disk is of such diameter that its periphery extends outwardly from the outer surface of the tube by a distance on the order of 1¾ inches. A cylindrical element 29 of electrically conductive material and of generally wedge-shaped cross-section and having its divergent side walls merging into its upper rounded, wider edge 30 is secured in a conformed recess 31 provided in the lower face of disk 27 adjacent its periphery. The opposite narrower edge 32 of element 29 projects beyond the plane of the lower face of disk 27 for a distance substantially equal to the thickness of the disk and in the general direction of discharge edge 16. Edge 32 is relatively sharp, but preferably the sharpness of this edge is substantially less than the sharpness of discharge edge 16 of tip 14. The assembled components of control member 26, just described, may be adjusted bodily, as a unit, longitudinally of tube 12 by simply rotating the member on the threads 17 to position the edge 32 closer to or further away from the plane of discharge edge 16.

When the edge 32 is of a relatively lesser degree of sharpness than edge 16, as just described and as shown in Fig. 1, it has been found in practice that best jet stabilizing, pattern controlling and atomizing results are obtained with the edge 32 positioned within a range from a position where it is coplanar with edge 16 to a plane behind said edge up to and inclusive of a distance of ⅛ of an inch. With 30 kv. applied to the tube 12 and with control member 26 adjusted as just described, element 29, through its close proximity to tube 12, receives by induction an electrical charge which is of sufficient intensity to create a secondary electrostatic field, completely around, in close proximity to, and coextensive with the primary atomizing or jet producing field. Such secondary field effects a greater stability to the projecting jet, counteracts the tendency of the particles in the outer portions of the jet to unduly spread or scatter and results in the obtaining of a more densified over-all deposition of the finely divided material upon the surface of the article, which tends toward rendering a deposited pattern having a relatively sharper edge definition than may be obtained in the absence of such secondary field. Desirably, the differential in the potential gradients of the two fields

adjacent the respective edges 16 and 32 should be adjusted and maintained in such balanced relation that the intensity created to produce the stabilizing and shaping effect shall always be slightly less than the corona discharge intensity produced to effect the atomization and projection of the coating material. Generally, this may be accomplished by the making of but a single, simple adjustment, that is, by rotating member 26 to advance or retract edge 32 toward or away from the plane of discharge edge 16. However, the potential gradient of the field terminating at the edge 32, while less than that at edge 16, may still be of sufficient intensity to produce a corona discharge.

It is noted that it has been found that as the degree of sharpness of edge 32 more nearly approaches the degree of sharpness of edge 16, effective concomitant jet stability and pattern controlling and proper atomizing functioning of the device requires edge 32 to be moved into a plane further behind the plane of the edge 16. That is to say, within a range from $\frac{1}{16}$ to $\frac{1}{8}$ inch. The distance between the separate planes occupied by the edges 16 and 32 is, of course, also governed to some considerable extent by the magnitude of the voltage applied to the tube, by the distance of the space between the element 29 and the tube, the relative discharge surface areas of the edges and also by the electrical insulating qualities of the material from which the disk 27 is fabricated.

Additional control means for establishing the proper balance in the difference in potential maintained between edges 16 and 32 may be provided if desired. This additional control constitutes a variable resistor 33 having a range on the order of 0-10 megohms connected as by means of conductors 34 and 36 across tube 12 and element 29 as shown. In such an arrangement, the element 29 receives its charge directly by conduction rather than by induction. It will be understood that the resistance means of adjustment may be used entirely independently of the screw-thread, planar-edge position adjustment, or vice-versa, or that both may be used together, the one to quickly bring the difference in potential into the proper general range and the other to obtain a precision degree of adjustment. Excellent atomization and jet stabilizing and pattern controlling results have been accomplished in using this type of head.

The rounding of the wider upper edge 30 of element 29 coupled with the backing of such edge by the rounded edge 31 of the disk 27, which it will be remembered is of nonconductive material, tends to prevent leakage or dissipation of charge from any portion of element 29 except at its discharge edge 32. If desired, with the element formed in general wedge-shaped cross section as shown, the element 29 can be mounted on the periphery of a disk such as 27 with its upper rounded edge 30 merging flush into the upper face of the disk, that is, without having the recess 31 provided in the disk and without the insulated backing to the upper rounded edge 30.

Fig 2 shows a form of electrostatic atomizing head in which the tube 212 is constructed of conductive material and in accordance with the dimensions and design of tube 12 of Fig. 1. Tube 212 is likewise threaded as at 217 adjacent its discharge edge 216 to receive the similarly threaded aperture 230 of a control member 226. Control member 226 is formed of conductive material in the general form of a disk 228 with a depending curved crown 232 formed integrally with is periphery. Depending crown 232 has a radius of curvature on the order of $\frac{1}{4}$" which serves as the jet-stabilizing and pattern-forming, field producing edge in this modification. With the lowest portion of the surface of the crown 232 adjusted to a position where it is coplanar with or tangential to the plane of the edge 216 and with a voltage on the order of 60 kv. impressed upon the tube 212, satisfactory atomization and spray pattern controlling effects have been produced with a head of this character. It is noted that the radius of curvature of the edge 232 presents a relatively much greater surface area than do the edges of the spray pattern controlling members heretofore described. The charge upon the disk 229 is in this instance received by conduction and this relatively more extensive surface area of the crown 232 is sufficient to reduce the intensity of the discharge emanating from the crown with respect to the corona atomizing discharge emanating from the edge 216, so that a proper balance in the differential of potential gradient in the spray atomizing and control fields is accomplished.

Figs. 3 and 4 illustrate a modified form of head in which the tube 312 delivers the coating material to an elongated chamber 340 of generally triangular cross section. The converging walls 342 of chamber 340 feed the coating material through a narrow aperture 343 formed between two opposed faces adjacent the lower ends of the walls 342 toward the lower projecting edge 316 of one of the side walls 342, the edge 316 constituting the discharge edge in this form of head. The secondary field establishing electrode in this embodiment takes the form of a pair of L-shaped wires 329 secured to the head at each end thereof and terminating in downwardly directed portions 330 located outwardly beyond the ends of the corona discharge edge 316 with their own ends in a plane slightly above that occupied by said edge. This type of head and its control electrode produces a generally elongate wedge-shaped jet that is substantially coextensive in length with the length of discharge edge 316. Each pair of auxiliary electrodes 330 establish at each end of the elongated jet a secondary or control field which stabilizes the end portions of the jet, densifies the end portions of the deposited spray pattern, and sharpens the definition at the ends of such pattern.

It will be understood that in instances in the foregoing description where it has not been specifically stated that the tube members which have the numeral 12 included in their reference numerals are connected to a high voltage source such as 21, that such tubes are connected to such a voltage source in order to effect their atomizing and control function in the organization of the apparatus. It may be desirable in certain instances to have the conductor such as 32 enter the tube and come into direct contact with the coating material.

I am aware that it is known to surround with an electrostatic field a carrier stream or jet of air or other gas which carries suspended particles of coating material and which is directed at and substantially normal to an extended surface to be coated. In such method, which is shown in U. S. Paten. No. 2,221,338, issued to Harry A. Wintermute, November 12, 1940, the field is employed for the purpose of precipitating coating-material particles which might otherwise be carried away with the air or other

ga escaping laterally from the point at which the stream or jet impinges upon the surface to be coated. In other words, the field acts to offset or counteract for the diverting effect of the article being coated on the carrier gas stream and is intended to act only on coating-material particles which have been subject to the consequences of that diverting effect. Many of the particles, especially those near the axis of the jet, are deposited without ever acquiring a charge and hence without benefit of the field; and the field neither shapes nor stabilizes the carrier gas stream nor affects in any way the initial direction of particles leaving the discharge head or nozzle.

The secondary or stabilizing field which is created by the auxiliary or control electrode 26, 226, or 326 in the practice of my invention functions in an entirely different manner Where the enclosing field of the prior art acted to precipitate coating-material particles in the desired region in spite of existent diverting influences tending to carry them beyond such region, I employ my stabilizing field to suppress the diverting influence or influences completely. I am enabled to do this because only electrostatic forces control and determine the respective paths of the coating-material particles during their atomization, their projection, and their deposition. It is an inherent characteristic of electrostatic fields that their lines of force cannot intercept or cross each other. Therefore, the secondary or stabilizing field of my invention distorts the primary (or the atomizing, projecting, and depositing) field, reduces its spread, and in general stabilizes it. As the coating-material particles, during the successive steps of their atomization, projection, and deposition, are accelerated along the lines of force of the primary field, the distorting effect of the secondary field on the primary field modifies the path of each individual particle in the outer portions of the jet from the instant such particle leaves the discharge head until it is finally deposited.

In the practice of my invention, the entire operation—i. e., the production of the spray and its control and deposition—is completely free of the turbulent, scattering, and difficultly controllable effects produced by air streams such as are customarily used in effecting atomization and spray-pattern control in conventional air-operated spray guns. The use of a single character of energy to effect atomization, projection, deposition, and pattern-control simplifies design and construction of the apparatus and effects a marked economy in its manufacture.

In the embodiments of my invention shown in Figs. 1 and 2, the electrodes 32 and 232 which create the respective stabilizing fields are circumferentially continuous and completely surround the jet-source. In many instances, it may not be deemed necessary to control and stabilize the entire peripheral portion of the jet; and in such instances the auxiliary electrode which creates the secondary field need not completely surround the jet-source. One such arrangement is contemplated in Figs. 3 and 4, where the secondary field created by the auxiliary electrodes 326 is fairly well confined to the region adjacent the ends of the elongated jet projected from the elongated discharge head. Where the auxiliary field is to have any considerable extent over the periphery of the projected jet, the discharge electrode may either have a relatively sharp edge continuous over the desired extent or it may comprise a plurality of pointed elements similar to the electrodes 326.

In electrostatic atomizing heads of the type set forth in the copending applications above referred to, the region outside of but immediately adjacent the projected jet will contain some lines of force terminating on the atomizing head above or in rear of the jet-source. The field which those lines of force might be regarded as constituting is not such a secondary stabilizing and controlling field as is employed in the practice of the present invention, primarily because its intensity is too low to produce any significant stabilization of the peripheral portions of the jet or any significant sharpening in the edge definition of the deposited pattern. For the accomplishment of my purpose, the composite electrostatic field, including both the component which has been herein referred to as the atomizing, projecting, and depositing field and the component referred to as the secondary or stabilizing field, must be characterized by the existence in, or approximately in, a plane spaced from the article surface being coated of two or more regions of relatively high potential gradient separated by an intervening region or regions of relatively low potential gradient, with atomization of the coating material taking place at one of the regions of high potential gradient while the other or others of such regions constitute the terminal portions of the secondary or stabilizing field. Thus, in each of the heads shown in Figs. 1 and 2, the field will have a region of high potential gradient at the discharge edge 16 or 216 and a second region of high potential gradient at the edge 32 or 232 of the control electrode; while in the region between the discharge edge and the edge of the control electrode the potential gradient of the field will be much lower. Similarly, in the device of Figs. 3 and 4, a region of high potential gradient will exist along the discharge edge 316 and at the tip of each of the control electrodes 326; but between each end of the discharge edge 316 and the tips of the adjacent control electrodes 326 the potential gradient of the field will be low.

Atomizing heads shown in the copending applications referred to above do not meet the requirements just mentioned; for the potential gradient of the field over the surface of the atomizing head decreases substantially progressively away from the localized region or regions at which atomization takes place.

I claim as my invention:

1. In the deposition of liquid material onto a surface, the steps of electrostatically atomizing liquid material from a source thereof, electrostatically projecting the atomized liquid material in the form of a jet onto the surface, and maintaining a corona discharge spaced from said source but sufficiently close to control the jet of atomized liquid material.

2. In the deposition of liquid material onto a surface, the steps of electrostatically atomizing liquid material from a source thereof, electrostatically projecting the atomized liquid material in the form of a jet onto the surface, and maintaining a corona discharge surrounding and spaced from said source but sufficiently close to control the jet of atomized liquid material.

3. In apparatus for electrostatically forming a divergent jet and applying particles of liquid coating material composing said jet upon a surface of an article, a nozzle having a discharge edge of knife-like sharpness, means for support-

ing said nozzle and presenting its discharge edge toward the article to be coated and in spaced relation therefrom, a tube communicating with said nozzle and adapted to convey a stream of said liquid material to said edge, an electrically conductive member having a discharge edge of a lesser degree of sharpness than said first named discharge edge, means for insulatingly supporting said conductive member with its discharge edge substantially coplanar with but in spaced relation from said first discharge edge and similarly presented in spaced relation toward the article to be coated, high voltage means connected with said first named edge for maintaining it at a potential different from the article and for creating a corona discharge thereabout to electrostatically atomize said material from said first edge and project such atomized material in particled jet form to the surface of the article to be coated, said high voltage means and first named edge being effective to impress by induction an electric field around the edge of said electrically conductive member of a potential sufficient to electrostatically stabilize the jet axially and shape the diverging spray formation of the particles as they are removed and propelled by the corona discharge emanating from said nozzle edge.

4. In apparatus for electrostatically coating an article with coating material, an applicator means, means for supporting said applicator means in spaced relation from an article to be coated, two members on said applicator means, said members having opposed surfaces defining a passage, one of said members projecting toward the article beyond said other member, a surrounding control member supported substantially coplanar with said projecting member in spaced relation therefrom, means for supplying coating material to the projecting member of said applicator means, and means for creating an electrostatic field of high potential between said applicator means and the article to be coated to electrostatically atomize the coating material delivered to said projecting member and electrostatically deposit it on the article being coated, said field creating means being also effective to create a surrounding field between said control member and said article.

5. Apparatus for applying atomized liquid coating material to an article, comprising an applicator means including a member with a discharge edge, means for supporting said applicator means with the discharge edge spaced from the article being coated, a control electrode supported in spaced relation to said discharge edge and the article being coated, means for supplying liquid coating material to said discharge edge, and means for creating an electrostatic field of high potential between said discharge member and the article to be coated to electrostatically atomize in the form of a jet the coating material supplied to said discharge edge and electrostatically depositing the atomized coating material on the article being coated, said field-creating means being also adapted to create a secondary electrostatic field between said control electrode and the article being coated for controlling the jet of atomized coating material.

6. Apparatus for applying atomized liquid coating material to a surface, comprising a head, means for supporting said head in opposed spaced relation to such surface, said head having spaced first and second projecting portions extending toward such surface, said second projection being annular and surrounding the first projection, means including a high-voltage source for maintaining between such surface and the first projection a primary electrostatic field capable of producing a corona discharge at the first projection and for maintaining a secondary field between the surface and second projection, and means for supplying liquid coating material to the first projection for atomization within such corona discharge, said primary field serving to precipitate on to said surface the electrically charged particles resulting from such atomization.

7. Apparatus as set forth in claim 5 with the addition, that said control electrode is annular and surrounds the discharge edge, said discharge edge extending toward the surface at least as far as does the control electrode.

8. Apparatus for applying atomized coating material to an article comprising a support for the article to be coated, an applicator means including a member with a discharge edge, means for supporting said applicator means with the discharge edge spaced from an article on said support, a control electrode supported in spaced relation to said discharge edge and the article being coated, means for supplying liquid coating material to said discharge edge, and means for creating an electrostatic field of high potential between said discharge member and the article to be coated sufficient to electrostatically atomize in the form of a spray the coating material supplied to said discharge edge and to move the spray particles through quiescent air and electrostatically deposit the atomized coating material on the article, the space between said discharge edge and the article on said support being sufficient to permit the spray particles to be dispersed during their movement toward the article, said field creating means being also adapted to create a secondary electrostatic field between said control electrode and the article being coated for controlling the spray of atomized coating material.

9. Apparatus for applying atomized coating material to an article comprising a support for the article to be coated, an applicator means including a member with an extended discharge edge, means for supporting said applicator means with the discharge edge spaced from an article on said support, a control electrode supported in spaced relation to said discharge edge and the article being coated, means for supplying liquid coating material to said applicator means, means for forming the material supplied to said applicator means into a thin sheet-like body having a longitudinal extent many times its transverse thickness and for moving the body toward said discharge edge, and means for creating an electrostatic field of high potential between said discharge member and the article to be coated sufficient to electrostatically atomize in the form of a spray the coating material from said body and to move the spray particles through quiescent air and electrostatically deposit the atomized coating material on the article, the space between said discharge edge and the article on said support being sufficient to permit the spray particles to be dispersed during their movement toward the article, said field creating means being also adapted to create secondary electrostatic field between said control electrode and the article being coated for controlling the spray of atomized coating material.

10. Apparatus for applying atomized coating material to an article comprising a support for

the article to be coated, a single fluid atomizing means including a member with a discharge opening, means for supporting said atomizing means with the discharge opening spaced from an article on said support, a control electrode supported in spaced relation to said discharge opening and the article being coated, means for supplying liquid coating material to said discharge opening, and means including another electrode for creating an electrostatic field, extending to the coating material supplied to said opening, and extending over the surface of the article to be coated of sufficient strength to electrostatically atomize in the form of a spray the coating material supplied to said discharge opening and to move the atomized spray particles through quiescent air and electrostatically deposit the atomized coating material on the article, the space between said discharge opening and the article on said support being sufficient to permit the spray particles to be dispersed during their movement toward the article, said field creating means being also adapted to create a

secondary electrostatic field between said control electrode and the article being coated for controlling the spray of atomized coating material.

EDWIN M. RANSBURG.

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Number	Name	Date
1,855,869	Pugh	Apr. 26, 1932
2,956,406	Darrah	May 15, 1934
2,074,935	Potthoff	Mar. 23, 1937
2,097,233	Meston	Oct. 26, 1937
2,187,306	Formhals	Jan. 16, 1940
2,221,338	Wintermute	Nov. 12, 1940
2,224,391	Huebner	Dec. 10, 1940
2,287,837	Smyser	June 30, 1942
2,359,476	Gravley	Oct. 3, 1944
2,421,787	Helmuth	June 10, 1947
2,446,953	Ransburg	Aug. 10, 1948
2,451,288	Huebner	Oct. 12, 1948
2,546,701	Ransburg et al.	Mar. 27, 1951
2,562,358	Huebner	July 31, 1951